VOL. XXIV, PARTS III & IV Published 31 December 1940

The British Mycological Society

(Recognosce notum, ignotum inspice)

TRANSACTIONS

Edited by

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Price to non-members, Fifteen Shillings

CAMBRIDGE UNIVERSITY PRESS
LONDON: BENTLEY HOUSE
CHICAGO: THE UNIVERSITY OF CHICAGO PRESS
(AGENTS FOR THE UNITED STATES)
BOMBAY, CALCUTTA, MADRAS: MACMILLAN
TOKYO: MARUZEN COMPANY LTD.

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The Cambridge University Press has appointed the University of Chicago Press agents for the sale of *The British Mycological Society's Transactions* in the United States of America.

VOLUME XXIV DECEMBER 1940 PARTS III & IV

OPHIOBOLUS GRAMINIS SACC. VAR. *AVENAE* VAR.N., AS THE CAUSE OF TAKE ALL OR WHITEHEADS OF OATS IN WALES

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I. INTRODUCTION

THROUGHOUT the wheat-growing areas of the world in which the Take All disease, due to *Ophiobolus graminis* Sacc., is prevalent, the growing of oats is regarded as a valuable control measure. Where attack by *O. graminis* is the factor limiting yield, a wheat crop following oats generally gives a yield equal to or approaching that of a crop after fallow. The empirical discovery of this fact is probably due to the farmers of South Australia, where a Commission was appointed as early as 1868 to inquire into the distribution caused by the disease, though its connexion with *O. graminis* was not established by McAlpine until 1902. Rotation of wheat with oats for the control of Take All was urged by McAlpine (1904) in Victoria, by Richardson (1910) in South Australia, and by Darnell-Smith & McKinnon (1915) in New South Wales.

This conclusion has been confirmed by pot experiments under controlled conditions demonstrating the high resistance of oats to infection by *O. graminis*; such experiments were reported by Wolf & Lehman (1924) and by Kirby (1925) in the United States of America, by Schaffnit (1930) and by Müller-Kögler (1938) in Germany, by Russell (1934) in Canada, and by Föex (1935) in France. Contrary results were, however, reported by Ducomet (1913) in France and by Osborn (1919) in South Australia; both examined specimens of diseased oats carrying perithecia of *O. graminis*. Darnell-Smith & McKinnon (1915) stated that a single case of oats attacked by Take All had been recorded in New South Wales. More recently, outbreaks of Take All in oats have been reported by Gram (1929) in Jutland, and by Van Poeteren (1932) in Holland. Hynes's (1937) claim to have demonstrated susceptibility of oats to two isolates of *O. graminis* in pot tests in New South Wales is of doubtful value. He tested six isolates, incorrectly designated strains, of *O. graminis* against three varieties of wheat, two of oats, and one each of barley and rye, in pots. Two of the isolates caused some retardation in growth of the oats. As the proportion of fungus inoculum (cooked wheat and oat kernels) to

surface soil was approximately 1 : 2 by volume, a purely toxic effect of the inoculum might well have caused the stunting.

Increasing interest in Take All in wheat and barley crops in this country during the last few years has made the immunity of oats an urgent matter. Field observations, such as that by Dillon Weston (1938) in Norfolk, suggest that oats may safely be recommended as a rotation crop for control of the disease. On the other hand, recent unpublished reports of Take All affecting oat crops in Wales, communicated by Mr D. Walters Davies and Dr T. Whitehead, have been too numerous and well-authenticated to be ignored. There are other records. Massee (1912) found plate mycelium and perithecia of *O. graminis* on diseased oat plants received at Kew from Corwen in North Wales, isolated the fungus and reproduced the disease in both wheat and oat seedlings, and Jones (1926) studied the cytology of development of the perithecium of *O. graminis* in material collected on oat stubble near Aberystwyth.

The susceptibility of oats to the Take All disease in Wales might be due to at least one of three possible causes, viz. the employment of peculiar varieties of oats, breakdown in resistance of the plant owing to some unfavourable condition of the environment, or the existence of a distinct biological strain of *O. graminis*, if not of another species of *Ophiobolus*, in Wales. The experiments described below are concerned both with the properties of the Welsh isolates of *Ophiobolus* from oats, and with the resistance of oats to English isolates of *O. graminis* from wheat.

II. Experimental

(*a*) *Isolation of* Ophiobolus *from oats and wheat*

Three isolates of the oat-attacking *Ophiobolus* were obtained in September 1937 from infected oats collected by Miss M. D. Glynne from Pentrevoelas, Denbighshire (isolate O 3), from Caervon, Anglesea (O 4), and from Beaumaris, Anglesea (O 13). Three further isolates were obtained in the late summer of 1938 from material collected by Mr D. Walters Davies at Aberystwyth (O 20), and from further collections made by Miss Glynne in Carnarvonshire, near Bodfaen (O 21) and near Edern (O 23). English isolates of *O. graminis* were made from infected wheat collected in 1937 from Dorset (W 1), from Broadbalk field, Rothamsted (W 2), and from Mr W. Buddin's experimental plots at Reading (W 3). In 1938, two further isolates (W 4 and W 5) were obtained from one collection of infected wheat from Wareham, Dorset.

Where ripe perithecia were present on infected stubble, *Ophiobolus* was most easily isolated by arranging for the ejection of ascospores on to a sterile cover-slip suspended not more than 1 mm. above the necks of the perithecia (Samuel & Garrett, 1933). If ripe perithecia were

not present, wheat or oat grains were planted in the cavities of selected pieces of infected stubble, which were then buried in pots of moist sand. Isolations of *Ophiobolus* were more readily obtained from the young lesions on infected seedling stems than from the original infected stubble, in which other fungi were always present. The silver nitrate method of surface sterilization recommended by Davies (1935) for the isolation of *O. graminis* was employed.

(*b*) *Host range of* Ophiobolus *isolates from oats and wheat*

Experiment I. In the first glasshouse inoculation experiment, six isolates of the fungus, three from oats (O 3, O 4 and O 13) and three from wheat (W 1, W 2 and W 3), were tested against Little Joss wheat and Victory oats in seven-inch pots of sand with a nutrient solution; each series comprised twenty replicate pots. The inoculation technique used by Garrett (1936) was followed, five pre-soaked wheat or oat grains being planted in each pot over agar inoculum disks 8 mm. in diameter, cut out with a cork borer from the margin of a colony of *Ophiobolus* growing on potato dextrose agar. The oat grains were dehulled before planting to increase percentage germination. After planting, the pots were randomized on the glasshouse bench, and watered once a week with the following nutrient solution:

Calcium nitrate ($Ca(NO_3)_2$)	0·8 g.
Potassium nitrate (KNO_3)	0·3 g.
Dihydrogen potassium phosphate (KH_2PO_4)	0·2 g.
Magnesium sulphate ($MgSO_4$, $7H_2O$)	0·2 g.
Potassium chloride (KCl)	0·2 g.
Ferric chloride ($FeCl_3$, $6H_2O$)	0·025 g.
Distilled water	1 litre

The plants from five pots of each series were washed out at fortnightly intervals from two to eight weeks, and pickled in 60% alcohol. The three oldest roots on each plant were examined under a binocular dissecting microscope (magnification, ×20) and the extent of growth of the runner hyphae measured (Garrett, 1936). The results for the first three samplings are given in Table I.

Table I. *Growth of fungus along the roots in mm.**

	W 1	W 2	W 3	O 3	O 4	O 13
After 2 weeks:						
On wheat	21 (±1·4)	29 (±0·7)	33 (±1·4)	15 (±0·6)	10 (±0·5)	19 (±1·0)
On oats	11 (±1·2)	4 (±0·8)	15 (±1·3)	8 (±1·0)	6 (±0·4)	8 (±0·3)
After 4 weeks:						
On wheat	40 (±2·1)	49 (±4·2)	45 (±1·7)	43 (±2·7)	25 (±2·2)	55 (±2·9)
On oats	14 (±1·3)	23 (±2·8)	45 (±2·7)	33 (±3·3)	24 (±1·6)	14 (±1·2)
After 6 weeks:						
On wheat	47 (±2·0)	50 (±·25)	41 (±1·9)	40 (±2·8)	31 (±1·7)	55 (±2·7)
On oats	30 (±3·6)	50 (±·76)	44 (±3·4)	35 (±2·6)	36 (±2·9)	40 (±2·7)

* The figures in brackets here, and in some subsequent tables, show the standard error.

The final sampling consisted of oats only; after washing out the plants, the tops were cut off about 1 cm. above the seed, and weighed.

Table II. *Weight of tops of oat plants, eight weeks old, inoculated with fungus isolates from wheat and oats*

	W 1	W 2	W 3	O 3	O 4	O 13
Mean fresh weight per plant in g.	3·4 (±0·2)	3·4 (±0·2)	3·6 (±0·2)	1·4 (±0·1)	0·8 (±0·2)	0·5 (±0·2)

The roots were not included in the examination, which comprised measurements both of extent of runner hyphae, and of length of root discoloured by infection; the figures are for the secondary roots formed at the first node.

Table III. *Infection of secondary roots of oat plants eight weeks old, inoculated with fungus isolates from wheat and oats*

	W 1	W 2	W 3	O 3	O 4	O 13
Mean hyphal growth in mm.	8 (±1·3)	28 (±6·1)	15 (±4·3)	39 (±5·6)	34 (±2·9)	24 (±5·3)
Mean length of root discoloured in mm.	1 (±0·8)	1 (±0·8)	1 (±0·7)	26 (±4·0)	28 (±2·5)	13 (±3·6)

The following conclusions were drawn from these results:

(1) Wheat was susceptible to isolates of *Ophiobolus* both from English wheat and from Welsh oats. The former (W 1, W 2 and W 3) produced the greater effect, many plants being killed after four to six weeks, but the type of infection and the appearance of the diseased plants were similar in all.

(2) Oats were highly resistant to the English isolates. Although runner hyphae had grown down the seminal roots for a considerable distance, the roots rarely showed any discoloration and were well developed. The secondary roots and subcoronal internode were generally free from hyphae, but in a few plants perithecia formed on the leaf bases.

(3) Oats were vigorously attacked by the Welsh isolates. O 13 was the most virulent, many plants being killed in six to eight weeks, and O 3 was the weakest. The root systems were poorly developed and severely attacked, both primary and secondary roots showing much discoloration.

Table I also shows that figures for the growth of runner hyphae of isolates from wheat and oats down the roots are not significantly different. Relying on this measurement alone, it would appear that oats are susceptible to all isolates used, but Tables II and III, giving weights of tops and extent of discoloration of the secondary roots, respectively, show that oats are seriously affected only by the isolates

from oats and are resistant to those from wheat. These observations indicate that, where different hosts are to be compared, infection is best estimated by the length of discoloured root; this figure may be supported by other data, such as the weight of tops of the plants.

Experiment II. Four varieties of oats, one of wheat, and one of barley were used in Experiment II, with the six isolates employed in Experiment I. The cereal varieties were Victory, New Abundance, and Scotch Potato white oats, Jubilee Black oats, Little Joss wheat, and Spratt Archer barley. There were thus thirty-six series, and four replicates of each were planted in ten-inch pots of sand with nutrient solution. Eight grains were sown over inoculum disks in each pot and seedlings thinned to five after ten days. After twelve weeks the tops were cut off and weighed.

Table IV. *Mean fresh weight in g. of tops of oat and wheat plants, inoculated with isolates from wheat and oats*

	W 1	W 2	W 3	O 3	O 4	O 13
Victory oats	11·8	11·4	13·4	9·3	7·6	7·7
New Abundance oats	11·0	13·7	12·4	8·2	5·0	6·8
Scotch Potato oats	12·3	11·0	10·6	7·7	7·0	9·5
Jubilee Black oats	11·7	12·0	10·2	6·2	2·5	11·1
Little Joss wheat	6·9	7·1	3·4	7·3	6·3	6·9
Spratt Archer barley	10·5	12·3	9·2	10·5	9·8	11·9

The roots were pickled in 2 % formaldehyde, and examined under the binocular microscope. The secondary roots only were considered, the primary roots having often disappeared. The total number of secondary roots, and number infected, were recorded for each plant; the percentage of infected roots for each series of twenty plants in four pots is given in Table V. These data show that the difference in

Table V. *Percentage infection of secondary roots of oat and wheat plants, inoculated with fungus isolates from wheat and oats*

Fungus isolate ...	W 1	W 2	W 3	O 3	O 4	O 13
Victory oats	6 (±2·0)	5 (±2·8)	9 (±4·0)	61 (±6·3)	91 (±2·8)	77 (±13·3)
Scotch Potato oats	3 (±1·7)	0	0	72 (±9·8)	71 (±10·0)	74 (±7·6)
Little Joss wheat	1 (±1·0)	58 (±1·7)	59 (±6·9)	10 (±6·1)	30 (±15·8)	35 (±14·1)
New Abundance oats	7 (±2·4)	2 (±1·7)	3 (±2·0)	97 (±2·0)	94 (±3·3)	72 (±14·3)
Jubilee Black oats	7 (±2·6)	4 (±2·8)	20 (±14·9)	79 (±11·1)	97 (±2·4)	73 (±5·1)
Spratt Archer barley	38 (±13·0)	25 (±8·8)	76 (±1·7)	27 (±10·5)	43 (±10·5)	21 (±14·0)

reaction of all four varieties of oats to the isolates from oats and to those from wheat is highly significant, thus confirming the findings of Experiment I. The differences in degree of attack on wheat and barley by the six isolates, on the other hand, scarcely appear to be significant, although a higher susceptibility of barley towards the isolates from wheat was suggested by the general appearance of the plants and the discoloration of the leaf bases.

Experiment III. This experiment was carried out in seven-inch pots of sand with a nutrient solution, later in 1938 with five new isolates, three from oats in Wales, O 20, O 21 and O 23, and two from wheat, W 4 and W 5. Three hosts were used, viz. New Abundance oats, Scotch Potato oats, and Little Joss wheat. There were thus fifteen series with six replicate pots per series; each pot was thinned to five plants. The pots were washed out after eight weeks, and the plants weighed and examined as before. The results are given in Tables VI and VII. These tables show that the new isolates behaved as those used in Experiments I and II, there being a sharp distinction in pathogenicity between the Welsh and English isolates. The three isolates from oats are seen also to differ amongst themselves, O 20 being the most virulent and O 23 attacking oats rather weakly, although its action on wheat is at least as strong as that of the other two oat isolates.

The oat isolates were again characterized by sparse development of runner hyphae on the outside of infected roots, as compared with that made by the wheat isolates. With the latter, the longitudinal extent of infection inside the root can generally be estimated by the extent of runner hyphal growth, the infection hyphae within the cells of the cortex seldom extending farther along the root than do the runner hyphae (Garrett, 1934, 1936). The isolates from oats, on the other hand, have greater powers of longitudinal spread inside the root, so that discoloration and infection may extend farther than the growth of runner hyphae on the outside of the root. Roots examined under the microscope, often showed runner hyphae entering the root and growing parallel to the surface in the subepidermal cells, cortical infection hyphae branching off in the usual way. This type of growth has been observed in wheat roots under certain conditions (Garrett, 1934), but it is much more usual in oat roots.

Experiment IV. In order to investigate further the respective host ranges of the isolates from wheat and oat, a series of nineteen common English pasture grasses was inoculated with isolates W 1, W 2, W 3, O 3, O 4 and O 13, respectively, in five-inch pots of sand with a nutrient solution. After eight weeks the extent of hyphal growth and of root discoloration was recorded, both for seminal and for crown roots. The results of this and of subsequent unpublished work, indicate that not one of these nineteen species of grass shows complete resistance even to the English isolates. In whatever way a disease rating was computed from these data, however, infection of the grasses by the Welsh isolates was both more intensive and more extensive than that by the English isolates. The complete data may be found elsewhere (Turner, 1939).

Table VI. *Mean fresh weight in g. of tops of oat and wheat plants, eight weeks old, inoculated with fungus isolates from wheat and oats*

Host	New Abundance oats					Scotch Potato oats					Little Joss wheat				
Isolate	W 4	W 5	O 20	O 21	O 23	W 4	W 5	O 20	O 21	O 23	W 4	W 5	O 20	O 21	O 23
Mean fresh weight	1·9	1·9	0·4	1·5	1·8	2·6	2·3	1·3	1·8	2·3	0·3	0·3	0·7	1·2	0·9
Number of dead plants	0	0	19	1	0	0	0	4	2	1	13	16	8	5	3

Table VII. *Percentage visible infection of seminal and crown roots of oat and wheat plants, inoculated with fungus isolates from wheat and oats*

Host	New Abundance oats					Scotch Potato oats					Little Joss wheat				
Isolate	W 4	W 5	O 20	O 21	O 23	W 4	W 5	O 20	O 21	O 23	W 4	W 5	O 20	O 21	O 23
Total number of seminal roots	132	141	109	122	118	144	137	134	143	143	145	146	112	133	145
Percentage visible infection	24	12	100	83	78	23	26	100	91	66	100	100	89	78	93
Total number of crown roots	150	157	81	145	107	210	174	184	156	177	147	148	103	133	182
Percentage visible infection	0	0	55	28	25	0	0	53	29	2	75	68	42	24	38

(*c*) *Pathological histology*

The course of infection of wheat roots by *O. graminis* has been followed in detail by Fellows (1928), Robertson (1932), and Garrett (1934). The chief characteristics of such infection are as follows: the invading mycelium is differentiated into coarse, dark-coloured runner hyphae, which grow down the outside of the roots, and more slender, hyaline infection hyphae, which branch off from these and enter the cells of the cortex. The hyphae penetrate the endodermis and invade the vascular tissues, which become severely discoloured; in these tissues, the hyphae tend to grow in a longitudinal direction. Hyphal penetration of the cell walls is frequently accompanied by the formation of highly characteristic callosities or lignitubers, first investigated by Fellows (1928). These outgrowths of the cell wall closely invest the invading hyphae, often extending some way into the cavity of the invaded cell, and sometimes appearing to prevent further growth of the enclosed hyphae. Lignitubers are frequently absent from cells invaded whilst still immature, and are generally strongest in cells infected after reaching maturity. In wheat roots eight or more weeks old, the hyphae sometimes disappear from the cells of the cortex, remaining only inside the vascular cylinder. The cortex, however, still shows obvious signs of disease, the cell walls being studded with persistent lignitubers.

The course of infection of oat and wheat roots by isolates W 4 and W 5 from wheat and isolates O 20 and O 21 from oats was followed in plants grown in sand and nutrient solution, and inoculated in the usual way under the seed; plants were washed out after ten days and subsequently at five-day intervals to fifty days. The external appearance of the plants and the extent of discoloration of the roots were noted, and the roots examined microscopically. Hand sections or whole roots were cleared in lactophenol, and stained with cotton blue. The degree of infection throughout the course of the experiment was somewhat variable in the different pots, some plants being very severely infected or completely killed after four or five weeks, while others, inoculated with the same isolate, remained almost unattacked. The more severely infected plants from all series were used for microscopical examination.

After twenty days, plants in six out of the eight series (the exception being oats inoculated with isolates W 4 and W 5, respectively) showed obvious signs of attack. The crown and leaf bases were blackened, and many of the plants were stunted. In this trial one of the isolates from oats, O 20, attacked wheat more vigorously, or at least more rapidly, than did isolates W 4 and W 5, causing very severe discoloration of the culm bases, and stunting of the root

system. At each sampling, from twenty days after planting to the final sampling after fifty days, the course of infection of wheat inoculated with all four isolates, and oats inoculated with isolates O 20 and O 21, was very similar. Penetration of the cortex had taken place in both hosts after ten days, being most evident in the proximal part of the root in contact with the inoculum disk. Hyphae were seen in the vascular tissue of wheat roots after ten days, and of oat roots after fifteen days; severe vascular discoloration was apparent after twenty days. Lignitubers were irregularly distributed throughout the infected roots of both hosts, being abundantly developed on the walls of some cells, and absent from others; their distribution could be correlated to some extent with the age of the cell when infected. The wefts of invading hyphae tended to develop into cones of mycelium, through progressive branching in the inner layers of the cortex. In older roots the lesions were no longer well defined, and infection was general throughout the cortex, though the distribution of hyphae was rather irregular. Most of the cortical cells were occupied by a few longitudinally running hyphae; here and there, however, cells were to be observed densely packed with transversely-running hyphae. Hyphae in the cortical cells of infected roots stained less deeply and became less healthy in appearance after six or seven weeks; the number of hyphae containing protoplasm steadily decreased as the plants aged. The lignitubers persisted, however, being more abundant in cells of wheat than in those of oat roots.

Infection of oat roots by the wheat isolates may now be described. In the early stages, infection followed a similar course to that by oat isolates, though less vigorous. After fifteen days, when there were abundant runner hyphae on the outside of the seminal roots, penetration had occurred at a few scattered points, and the hyphae had not penetrated inwards through more than two or three cell layers. After twenty days there were occasional lesions on the roots in which penetration was heavy and had extended to the endodermis. In a few roots, hyphae were seen at this stage inside the vascular cylinder, which showed some localized discoloration. Lignitubers were formed freely in many of the infected cells, though not in cells in the centre of lesions, and these appeared sometimes to have checked the spread of the hyphae. After twenty-seven days, the roots showed less obvious infection than after twenty days. Scattered groups of cells showed hyphae that appeared to be disintegrating, as indicated by their weakly staining properties and attenuated appearance, whilst other cells showed prominent lignitubers but no visible hyphae. Even in those taken after thirty-four and forty-one days, the roots still showed occasional localized lesions with persistent hyphae; occasionally penetration hyphae from the runner hyphae had branched in a single superficial cell until this was closely packed with stout coiled hyphae.

Amongst all samples examined from the experiment, crown root lesions were found only twice, although occasionally runner hyphae grew along the outside of these roots.

It therefore appears from these observations that the resistance of oat roots to isolates of *O. graminis* from wheat is of the chemical rather than the mechanical type (Brown, 1936).

(*d*) *Morphological and cultural characters of the isolates*

It was found impossible to distinguish the six Welsh isolates of *Ophiobolus*, obtained from oats, by their appearance in culture from typical isolates of *O. graminis* obtained from wheat. On the basis of colour and other colony characters on potato-dextrose agar, the isolates O 3–O 23 might all have been identified as *O. graminis*. Their growth rate was also comparable to that of isolates W 1–W 5 from wheat. A comparison of growth rate on a series of potato dextrose agars adjusted to different reactions from *p*H 4·0 to 9·0 showed that the oat isolates preferred if anything an initial reaction on the acid side of neutrality, whereas the wheat isolates grew best on a neutral or slightly alkaline medium. The range for suboptimal growth of both series of isolates was wide, however, and the differences were no greater than those obtained by Webb & Fellows (1926) in their study of the growth of several isolates of *O. graminis* on a number of different nutrient agars adjusted to a range of *p*H values.

Sharp differences were found, however, in ascospore measurements of the two series of isolates. Perithecia were obtained by Garrett's (1939) method, whereby agar-inoculated wheat seedlings were grown in boiling tubes half filled with sand plus inorganic nutrient solution, exposed to light in a north window of the laboratory. Perithecia generally matured in less than two months, on stems and especially on roots exposed to the light. The first series of tubes, containing wheat seedlings inoculated with isolates W 2, W 3, O 3, O 4 and O 13, respectively, was set up in March 1938. Measurements of the length of one hundred ascospores, taken from not less than five ripe perithecia, were made for each isolate (Table VIII).

Table VIII. *Ascospore measurements in* μ

	W 2	W 3	O 3	O 4	O 13
Mean length	86 ($\pm 0{\cdot}40$)	84 ($\pm 0{\cdot}31$)	116 ($\pm 0{\cdot}36$)	105 ($\pm 0{\cdot}27$)	110 ($\pm 0{\cdot}26$)
Modal length	90	84	118	108	112
Range in length	68–104	72–102	102–130	94–130	84–130
Mean number of septa	8·5	8·0	11·0	11·5	12·5

In the second series set up in February 1939, wheat and barley seeds were inoculated with isolates W 4 and W 5, and wheat and oat

seeds with isolates O 20, O 21 and O 23, respectively. The length of one hundred ascospores, taken from not less than five perithecia, was again measured; in the O isolates, measurements of ascospores from perithecia formed on two hosts may be compared (Table IX).

Table IX. *Ascospore measurements in* μ

	W 4	W 5	O 20	O 21	O 23
On wheat	80 ($\pm 0{\cdot}35$)	79 ($\pm 0{\cdot}29$)	104 ($\pm 0{\cdot}42$)	124 ($\pm 0{\cdot}43$)	117 ($\pm 0{\cdot}40$)
On oats	—	—	106 ($\pm 0{\cdot}41$)	117 ($\pm 0{\cdot}38$)	113 ($\pm 0{\cdot}39$)

The length of the ascus for different isolates on different hosts is given in Table X, which shows that this character differs as significantly as the length of the ascospore in the two series of isolates, but there is no consistent effect of host upon the length of the ascus.

Table X. *Ascus measurements in* μ

	W 4	W 5	O 20	O 21	O 23
On barley	103 ($\pm 0{\cdot}71$)	116 ($\pm 1{\cdot}0$)	—	—	—
On wheat	100 ($\pm 0{\cdot}57$)	112 ($\pm 0{\cdot}87$)	120 ($\pm 1{\cdot}22$)	138 ($\pm 0{\cdot}73$)	138 ($\pm 0{\cdot}56$)
On oats	—	—	128 ($\pm 0{\cdot}90$)	133 ($\pm 0{\cdot}59$)	131 ($\pm 1{\cdot}0$)

Measurements of the length of the ascospore were also made from naturally infected material. The length of one hundred ascospores, taken from at least five perithecia, was determined from three different collections of infected oat stubble, which subsequently gave isolates O 20, O 21 and O 23, respectively, in the autumn of 1938 (Table XI).

Table XI. *Ascospore measurements in* μ

	O 20	O 21	O 23
Mean length	101 ($\pm 0{\cdot}59$)	110 ($\pm 0{\cdot}52$)	117 ($\pm 0{\cdot}54$)
Modal length	99	115	115
Range in length	86–122	90–131	97–140
Mean no. of septa	10	12	12

Status of fungus from oats

The isolates from oats thus differ significantly from those from wheat in the length of the ascospore, as well as in host range. The two series of isolates are, however, very similar in cultural appearance and in the symptoms produced in susceptible hosts. Miss E. M. Wakefield has kindly confirmed the difference in ascospore length, and from this and the other characteristics considers that the isolates from oats should be regarded as a new variety of *O. graminis*.

Ophiobolus graminis Sacc. var. *Avenae* E. M. Turner a typo in longioribus sporis (101–117 μ) et in planta hospitali, *Avena sativa*, differt.

Summary

Outbreaks of Take All in oats have often been reported in recent years from Wales, and occasionally from Australia, Denmark and Holland, although in most parts of the world it is commonly held that oats resist the disease. Isolates of *Ophiobolus* from oats grown in Wales were indistinguishable in cultural behaviour from *O. graminis*, but they were very pathogenic to oats, which were found to be highly resistant to ordinary *O. graminis*.

This histology of the infection of oat plants by the fungus from Wales and by *O. graminis* was studied in detail. It was found that there were significant differences between the two groups of isolates in the length and septation of the ascospores, the Welsh material giving a length of 101–117 μ, the English material 79–86 μ.

The fungus from Welsh oats is therefore regarded as a new variety, *Ophiobolus graminis* Sacc. var. *Avenae* E. M. Turner.

I have much pleasure in recording my grateful thanks to Mr S. D. Garrett, who suggested this problem and supervised the work, and to Miss E. M. Wakefield for her advice on the systematic status of the isolates of *Ophiobolus* from oats.

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(*Accepted for publication* 10 *July* 1940)

NOMINA GENERICA CONSERVANDA

CONTRIBUTIONS FROM THE NOMENCLATURE COMMITTEE OF THE BRITISH MYCOLOGICAL SOCIETY. III

(Secretary: E. M. Wakefield)

Since the publication of the last contribution (these *Transactions*, xxiii, 1939, 281) the Committee has been enlarged by the addition of Dr G. C. Ainsworth.

The following statements set out the arguments for and against twelve more of the proposals for conservation of generic names of fungi which were published in the Supplement to the *International Rules*, 1935. The recommendations made are with one exception the unanimous opinion of this Committee. In the matter of *Agaricus* versus *Psalliota*, opinion was divided, and the majority recommendation is given.

The Committee regrets that in the statement on *Urocystis* versus *Tuburcinia* (*Trans. Brit. mycol. Soc.* xxiii, 1939, 223) an error was made with regard to Ciferri's genus *Ginanniella* (loc. cit., last sentence on the page). Dr Ciferri has pointed out that his genus was founded on the presence of a conidial stage, and that his diagnosis admits the presence of cortical cells in the spore-balls. This, however, does not affect the argument for the conservation of *Urocystis*.

Cordyceps (Fr.) Link

On p. 121 of *International Rules* there is a proposal to conserve "*Cordyceps* Fr. Summ. Veg. Scand. (1849) 381.—T.: *C. militaris* Fr. l.c." against "*Cordiceps* Link, *Handb.* iii (1833) 347". [The page reference should be "346".]

This proposal is apparently based on a mistake by Winter in *Rabenhorst Kryptogamen-Fl. Deutschl.* i, ii, 148–50 (1885), where "*Cordiceps* Link (*Handbuch*, iii, 347)" is cited in the synonymy of four species. But Link in *Handbuch*, iii, 346 used the same spelling, *Cordyceps*, which everyone else uses. The generic name is *Cordyceps* (Fries [ut "Trib." sub *Sphaeria*, *Syst. Mycol.* ii, ii, 323, 1823]) Link (1833), and is accordingly in no need of conservation.

Recommendation. The proposal to conserve *Cordyceps* (Fr.) Link against "*Cordiceps* Link" should be rejected as unnecessary.

Dubitatio Speg. (1881) versus *Spegazzinula* Sacc. (1883)

The proposal published in the Appendix to the *International Rules*, 1935, is to conserve *Spegazzinula* Sacc. *Syll.* ii, 537 (1883) against *Dubitatio* Speg. *Fung. Arg. Pug.* iv, no. 202 (1882).

Dubitatio Speg. in *Anal. Soc. Cientif. Argentina*, xii, 212 (p. 77 of reprint) (1881).

Spegazzini proposed *Dubitatio dubitationum* gen. et sp. nov. There was and is

no rule to prevent the use of *Dubitatio* as a generic name, and *D. dubitationum* is not a tautonym, as the specific epithet does not exactly repeat the generic name (see, for example, *Barbarea Barbareae*, *J. Bot.*, *Lond.*, LXIII, 183 (1925)).

Spegazzinula Sacc. in *Syll. Fung.* II, 537 (1883).

Saccardo stated (wrongly) that *Dubitatio* was "nomen prorsus exlex", proposed *Spegazzinula* nom.nov. in its place, and made the combination *S. dubitationum* (Speg.) Sacc. This was the only known species until 1903, when *S. juglandina* von Höhn. was described. No other species is recorded up to 1928.

The name *Spegazzinula* was accepted by Clements & Shear, *Gen. Fungi*. They do not mention *Dubitatio*, but von Höhnel accepted it in his later publications, since he wrote "*Dubitatio* (=*Spegazzinula*)" in *Fragmente* nos. 391 and 604.

Recommendation. *Dubitatio* is a valid name, validly published, and it seems unnecessary to conserve the later *Spegazzinula* for two little-known species.

Daldinia Ces. & de Not. (1863) versus *Perisp*[*h*]*aeria* Rouss. (1806), *Perispherostoma* Gray (1821) and *Hemisphaeria* Klotzsch (1843)

Species of *Daldinia* are characterized by their phaeosporous ascospores and by the internal zonation of their stromata, a feature which distinguishes them at sight from the subglobose species of *Hypoxylon* of which they are a segregate. This character was plainly observed and figured by Bolton in 1791, and suggested to him the specific epithet of his *Sphaeria concentrica*, but generic significance was not attributed to it until 1863, when Cesati and de Notaris incorporated it in the diagnosis of *Daldinia* as "stroma intus transverse concentricum".

Daldinia Ces. & de Not. in *Comm. Soc. Critt. Ital.* I, 197 (1863).

The genus was published with two species, *D. concentrica* (Bolt. ex Fr.) Ces. & de Not., and *D. vernicosa* (Schwein.) Ces. & de Not. The first was much the better known to the authors and may be accepted as the type. The genus is well known and is universally accepted in all systematic works and text-books.

The other genera under discussion are derived directly or indirectly from Persoon's section of *Sphaeria*, "Peripherícae", which was established to take all species that have cushion-shaped stromata, with peripheral perithecia: it took no account of their ascospore characters. Its thirteen species, in Saccardo's terminology, were *Daldinia concentrica* (first), seven species of *Hypoxylon*, *Hypocrea gelatinosa* and *H. rufa*, *Melogramma vagans*, *Plowrightia ribesia* and *Dothidea Sambuci*.

Perisp[*h*]*aeria* Rouss. *Fl. Calvados*, 42 (1806) and *Perispherostoma* Gray, *Brit. Pl.* I, 513 (1821).

Both these genera are based directly on Persoon's section "Peripherícae"; in both, *Daldinia concentrica* heads the list of species; in neither is the concentric zonation of its stromata considered as more than a specific character, and the ascospore characters are not considered at all. Both genera are invalid because pre-*Systema*, and neither would clash with *Daldinia*, unless its first species were arbitrarily selected as the type. Neither has been taken up, and there appears no reason why either should be.

Hemisphaeria Klotzsch in *Nova Acta Leop. Carol.* XIX, Suppl. I, 241 (1843).

The genus was published by Klotzsch, but attributed by him to Nees in *Systema*, 290 (1817). Nees, however, did not propose *Hemisphaeria* as a genus, but proposed a "Halbkugelsphärien Sphaeriae Hemisphaericae" as a section of *Sphaeriae*, which covered the same ground as Persoon's section "Peripherícae". Again *Daldinia concentrica* was the first species mentioned.

Klotzsch published a generic diagnosis, in which the stromata were characterized by the peripheral perithecia, but restricted the genus to species with phaeosporous

ascospores. He did not make the zonation of the stromata a generic character, and hence did not intend to exclude the main mass of species of *Hypoxylon* that have cushion-shaped stromata. The only species he mentioned was *Hemisphaeria concentrica* which accordingly must be the type species.

The genus *Hemisphaeria* Klotzsch has never been taken up, but it was validly published. As it antedates *Daldinia* and has the same type species, it provides the nomenclaturally correct name for that genus.

Recommendation. As the name *Daldinia* is universally recognized and accepted, and the earlier *Hemisphaeria* is virtually unknown, and has never been taken up, it is recommended that *Daldinia* Ces. & de Not., type species *D. concentrica* (Bolt. ex Fr.) Ces. & de Not., be conserved against *Hemisphaeria* Klotzsch.

The names *Perisphaeria* Rouss. and *Perispherostoma* Gray are invalid and need not be conserved against.

Note. In the published proposal, *Cercidospora* Körber was included by a printing error as a synonym of *Daldinia*. It really clashes with *Didymella*.

Hypospila Fr. (1825), *Hypospila* Karst. (1873) and *Phoma* Fr. (1823)

The proposal before the Congress (*International Rules*, 1935, p. 121) is to conserve *Hypospila* Fr. [*Syst. Orb. Veg.* (1825?), 109] *Summ. Veg. Scand.* (1849), 421, with type *H. pustula* (Fr. *Syst. Mycol.* II, 547, sub *Phoma*) Karst. *Mycol. Fenn.* 127 against *Phoma* Fr. *Syst. Mycol.* II (1822), 546. The proposal is complementary to the proposal to conserve *Phoma* Desm. non Fr. which was examined in *Trans. Brit. mycol. Soc.* XXIII, 289 (1939).

Phoma Fr. *Novit. Flor. Suec.* 80 (1819) and *Syst. Mycol.* II, ii, 546 (1823).

When he proposed the genus in 1819, Fries specified *Sphaeria pustula* Pers. as type. As already stated (loc. cit.) it is an Ascomycete. In 1823 he included (1) *Phoma saligna* (now placed in *Linospora*—another Ascomycete), (2) *P. Populi* and (3) *P. filum* (both uncertain), (4) *P. pustula*, and (5) *P. tularostoma* (compiled by Saccardo as *Phoma*).

Hypospila Fr. *Syst. Orb. Veg.* 109 (1825).

Fries described *Hypospila* as an Ascomycete, "Typus est *Spiloma inustum* Ach." Part of Acharius's type specimen of *S. inustum*, from Sierra Leone, was found by Petrak & Sydow (*Ann. Mycol.* XXI, 370, 1923) to have no definite fungus structure. Hence they claimed that the name *Hypospila* Fr. should be rejected.

In *Summ. Veg. Scand.* II, 421 (1849) Fries again listed *Hypospila* with *H. inusta* as type, but placed in it also "*H. quercina* s. *bifrons*" (later made the type of the genus *Hypospilina* Trav.) and "*H. populina* s. *ceuthocarpa*" (which was made the type of *Ceuthocarpon* Karst.). He still maintained *Phoma* Fr., with four species, including *P. pustula*.

Karsten in *Mycol. Fenn.* II, 127 (1873) transferred *Phoma pustula*, the type of the genus *Phoma* Fr., to *Hypospila*. Saccardo in *Syll. Fung.* II, 189 (1883) followed Karsten and placed *H. pustula* as the first species of *Hypospila*. Most mycologists subsequently have considered this the "typical" species. Only eleven species of *Hypospila* have been compiled in the *Sylloge*. Only *H. pustula* is included in *Hypospila* by Traverso in *Flora Italica Crypt.* Fasc. 2, 346 (1906).

Von Höhnel in 1918 (*Ann. Mycol.* XVI, 97) proposed the monotypic genus *Chalcosphaeria* for *H. pustula*.

The pith of the proposal is to replace the real type species of *Hypospila* Fr. (*H. inustum*) by *H. pustula* (Fr.) Karst.; that is, to make a new genus *Hypospila* Karst., and to conserve it against *Hypospila* Fr. (1825) and *Phoma* Fr. (1823).

Recommendation. It has already been recommended (loc. cit.) that *Phoma* Desm. be conserved against *Phoma* Fr. If this is accepted it becomes unnecessary to

conserve *Hypospila* Karst. against *Phoma* Fr. As however the name *Hypospila* has been so confused, and includes so few species, none of which is of economic importance, it is recommended that a genus *Hypospila* Karst. be not erected, and that the genus *Chalcosphaeria* von Höhn., type species *C. pustula* (Fr.) von Höhn., be accepted.

Massaria de Not. (1844) versus *Splanchnonema* Corda (1829)

Massaria de Not. in *Giorn. bot. ital.* I, 333 (1844).

De Notaris characterized his genus as having simple perithecia which collapse when dry, and large asci which contain ovate, trilocular [i.e. bi-septate], coloured ascospores, each enclosed in a layer of mucilage.

The genus was monotypic, being based on "*Massaria inquinans* de Not.—*Sphaeria inquinans* Tode", and in an expanded form has been generally accepted by mycologists. Unfortunately "*Massaria inquinans* de Not.", which has ovate, or better, obovate, 2-septate ascospores, is distinct from *S. inquinans* Tode ex Fr. which has oval 3-septate ascospores. The latter is often cited as "*Massaria inquinans* (Tode ex Fr.) Fr." As the genus is now used, it includes all the species with phaeo-phragmospores, and hence both Tode's species, and that of de Notaris.

In Saccardo's *Sylloge*, III, p. 3, "*M. inquinans* de Not." is cited as a synonym of *M. loricata* Tul., which in turn is held to be barely distinct from *M. foedans* (Fr.) Fr.

It is submitted that the type species of the genus is correctly cited as "*Massaria inquinans* de Not., nec *Sphaeria inquinans* Tode ex Fr."

Splanchnonema Corda in Sturm, *Deutschl. Flora*, III, ii, 115 (1829).

The genus was based on *S. pustulatum* Corda, the fruit bodies of which were said to occur between bark and wood as felty elevations filled with yellowish asci containing three-celled ascospores. Corda thought that his fungus lacked both perithecia and stromata.

The genus was misconceived by Corda, and remained unused, although a number of writers commented on the resemblance between *Splanchnonema pustulatum* and *Massaria foedans*. In 1898, O. Kuntze (*Rev. Gen. Pl.* III, 530) accepted as a fact that they were identical, and hence that *Splanchnonema* Corda was the valid name of *Massaria* de Not. He accordingly transferred all the species, but has not been followed by anyone else.

Recommendation. As *Massaria* has been accepted since its foundation, and *Splanchnonema* has been taken up only by O. Kuntze, it is recommended that *Massaria* de Not., 1844, type species "*M. inquinans* de Not. nec *Sphaeria inquinans* Tode ex Fr.", be conserved against *Splanchnonema* Corda (1829).

Teichospora Fuckel (1869), *Strickeria* Körber (1865) and *Sphaeria* Fries (1823)

The proposal is to conserve *Teichospora* Fuck. *Symb. Mycol.* 160 (1869) against *Strickeria* Körb. *Parer.* 400 (1865) and *Sphaeria* Fr. *Syst. Mycol.* II, 319 (1823) emend. de Not. *Comm. Soc. Critt. Ital.* IV, 220, pro maxima parte (1863).

Teichospora Fuck. *Symb. Mycol.* 160 (1869).

The genus *Teichospora* was founded by Fuckel for Pyrenomycetes with simple, superficial perithecia and yellowish, muriform ascospores. He described five species and named *T. trabicola* as his type. Later (in *Nachträge*, I, 350) he described a further three species. The genus has been accepted by Saccardo, *Syll.* II, 290 (1883), who compiled thirty-three species. The genus has also been accepted by Ellis & Everhart, *North Amer. Pyrenomycetes*, 212 (1892); Berlese, *Icon. Fung.* II, 44 (1895); and by Clements & Shear, *Genera of Fungi*, 276 (1930) with *T. obducens* (Fr.) as the type.

Strickeria Körb. *Parer.* 400 (1865).

Strickeria was founded on *S. Kochii* Körb. The spores were described as coloured but no septation was mentioned, and the fructification was described as an apothecium. Rehm (in *Hedwigia*, XVIII, 113, 1879) demonstrated that *Teichospora* Fuck. is synonymous with *Strickeria* Körb. Winter (in Rabenh. *Kryptogamen-Fl. Deutschl.* II, 281, 1885) stated that he agreed with Rehm and drew attention to the fact that the ascospores of authentic material are muriform. He therefore adopted the genus *Strickeria* and cited seventeen species. This genus has also been accepted by Lindau in Engler & Prantl, *Nat. Pflanzenfam.* I, 416 (1897); Migula, *Kryptogamen-Fl. Deutschl.* III, 233 (1913); Lind, *Danish Fungi*, 198 (1913); Schroeter, *Die Pilze Schlesiens*, II, 332 (1908); and by Kirschstein in *Kryptogamen-Fl. Mark Brandenburg*, VII, ii, 265 (1911).

Sphaeria Fr. *Syst. Mycol.* II, 319 (1823) emend. Ces. & de Not. *Comm. Soc. Critt. Ital.* IV, 220, pro maxima parte (1863).

The genus *Sphaeria* has included the whole of the Pyrenomycetes. Cesati & de Notaris (loc. cit.) restricted it to include only species which possess superficial or partly sunken perithecia and three to many septate, dark-coloured ascospores. In Saccardo's *Sylloge* it was reserved for the residue of *Sphaeriaceae imperfecte cognitae*. Although under Art. 51 of the *International Rules* the name *Sphaeria* should have been preserved as a valid name for a section of the original genus, it has been applied to such diverse groups of species, and has been omitted for so many years from all mycological works, that it would be most undesirable for it to be restored in the restricted sense of Cesati & de Notaris.

Recommendation. As *Strickeria* provides both the first validly published name and also the most widely used name for the genus, it is recommended that the proposal to conserve *Teichospora* against it be rejected, and that *Sphaeria* Fr. emend. Ces. & de Not. be not restored.

Dothidella Speg. (1880) and *Plowrightia* Sacc. (1883)

The published proposal is to conserve *Plowrightia* Sacc. against *Dothidella* Speg. "*An. Soc. Sc. Argent.* XI (1881) 69".

Plowrightia belongs to the Dothideae, i.e. its stromata are erumpent. *Dothidella* was for many years accepted as a member of the Phyllachorae, which have immersed stromata. In 1915 Theissen & Sydow nominated as type species *Dothidella achalensis* Speg., a species with erumpent stromata, and this in effect transposed *Dothidella* into an earlier name for *Plowrightia*. Both genera have hyaline two-celled ascospores.

Dothidella Speg. (1880).

The name *Dothidella* first appeared in a table entitled "Nova Systematis Carpologici Dispositio" on an unnumbered page following p. 176 (p. 192 in reprint) of "Fungi Argentini. Pugillus primus" in *Anal. Soc. Cientif. Argentina*, IX (1880). Of the eight genera there accepted as belonging to the Dothideaceae, *Scirrhia* Nits., *Euryachora* Fuck. and *Dothidella* Speg. were tabulated as Hyalodidymae. A footnote ran "*Dothidella* Sp[eg]. Est *Dothidea* sporidiis hyalinis donata". This is not enough description for the precise recognition of the genus, since *Dothidea* is the only representative of Dothideaceae-Phaeodidymae in his table. No species was mentioned, and it is evident that the genus was not validly published in this place.

Later in the same year, in "*Fungi Argentini.* Pugillus secundus", *Anal. Soc. Cientif. Argentina*, X, 21 (1880), Spegazzini described a single species, *Dothidella australis*, on living leaves of *Solanum*. It is submitted that in accordance with Art. 43 this description validated the name *Dothidella*, and *D. australis* is therefore the type species of the genus.

D. australis was followed by "*Dothidea*? *Lorentziana*", described briefly without

characters of asci and spores, which were deficient because immature. From this it may be concluded that Spegazzini at this time was using the name *Dothidea* not only for Dothideaceae-Phaeodidymae, but also for Dothideaceae-Incertae.

In "Pugillus quartus" *Anal. Soc. Cientif. Argentina*, XII, 69–70 (1881), Spegazzini described *Dothidella achalensis*, *D.? gracilis* and *D. Hieronymi*. Having found the ascospores of *Dothidea Lorentziana*, and that they were hyaline and one-septate, he transferred it to *Dothidella* with a new diagnosis. In 1908 he transferred *Dothidella Hieronymi* to *Plowrightia*.

Saccardo, *Syll. Fung.* II, 627 (1883) compiled *Dothidella* with the remark "Est quasi *Phyllachora* hyalodidyma".

When Theissen & Sydow, *Ann. Mycol.* XIII (1915), monographed the Dothideales under 140 genera, they transferred *Dothidella australis* and *D. Lorentziana* to their genus *Placostroma* in the "Phyllachoraceae". They were able to redescribe *Dothidella australis*, presumably from the Exsiccata which they cite, "Speg. Decad. Myc. Argent. n. 42". It should be noted that *D. australis* was the only one of Spegazzini's first five species which they were able to study from authentic material.

Theissen & Sydow would no doubt have chosen *D. australis* as the type of *Dothidella* had they not overlooked the fact that it is the first species described; for they argue (p. 307) that the genus should be based on the first species, which they erroneously state to be *D. achalensis* Speg. They did not see a specimen of this species, but considered that the description made it clear that it belonged in their "Dothideaceae", and was a *Plowrightia*. They therefore placed *Plowrightia* as a synonym of *Dothidella*.

Spegazzini himself never considered *Plowrightia* a synonym of *Dothidella*. As mentioned above, he transferred *D. Hieronymi* to *Plowrightia*, and he described new species of *Plowrightia*, one as late as 1919, four years after Theissen & Sydow's monograph.

The name *Dothidella* is then an earlier name for *Placostroma*, or perhaps a *nomen ambiguum* through its incorrect use in the standard work on the Dothideales.

Plowrightia Sacc. in *Syll. Fung.* II, 635 (1883).

Plowrightia Sacc. is the correct name for the erumpent, hyalodidymous Dothideae compiled by Theissen & Sydow erroneously under *Dothidella*. *Plowrightia ribesia* (Pers. ex Fr.) Sacc. is the type.

Recommendation. It is recommended that *Dothidella* Speg. be held to have been first validly published in "Fungi Argentini. Pugillus secundus" (1880). From that it will follow that *D. australis* Speg. must be accepted as its type species, that *Dothidella* belongs to the Phyllachorae, that it accordingly does not clash with *Plowrightia* of the Dothideae, and that the proposal to conserve *Plowrightia* is unnecessary.

Pseudographis Nyl. (1855) versus *Krempelhuberia* Massal. (1854)*

The published proposal reads: under Nomina conservanda, "*Pseudographis* Nyl. Essai Nouv. class. Lichens in: *Mém. Soc. Sc. Nat. Cherbourg*, II (1855) 190.—T.: *P. elatina* (Fr. *Syst. Mycol.* II, 584, sub Hysterio) Nyl. *Herb. Mus. Fenn.* 96". Under Nomina rejicienda, "*Krempelhuberia* Massal. *Esam. Lich.* (1854) 34". Various corrections are made below.

Krempelhuberia Massal. in *Geneacaena Lich.* 14 (1854).

The genus was founded on one species, *Krempelhuberia Cadubriae*. This name has apparently never been taken up by lichenologists or mycologists. Saccardo, *Syll. Fung.* II, 769 (1883), placed *K. Cadubriae* Massal. as a synonym of *Pseudographis elatina*, and subsequent authors have accepted this.

* With the co-operation of Mr I. M. Lamb, British Museum (Natural History).

Pseudographis Nyl. in *Mém. Soc. Sci. Nat. Cherbourg*, III, 190 (1855).

Nylander proposed the genus *Pseudographis*, based on *Lichen elatinus* Acharius (1798) (=*Hysterium elatinum* (Ach.) Pers. 1801), and made the combination *Pseudographis elatina*. He used the same combination in later publications (including *Herb. Mus. Fenn.* 96, 1859) but in 1857 he remarked in his "Enum. gén. Lichens": "*Pseudographis* Nyl. Potius fungus". Since about 1860 lichenologists and mycologists have agreed that *P. elatina* is a fungus, and *Pseudographis* has been accepted in mycological literature for eighty years. The type species may be cited as *P. elatina* (Ach. ex Fr.) Nyl. A dozen species have been described.

Recommendation. As the name *Krempelhuberia* Massal. (1854) has not been accepted, whereas *Pseudographis* Nyl. (1855) has received general acceptance as a fungus, it is recommended that *Pseudographis* be conserved against *Krempelhuberia*.

Hexagonia Poll. (1816), *Hexagona* Fr. (1836–8) and *Scenidium* (Kl.) O. Kuntze (1898)

The proposal published in the *International Rules*, 1935, p. 123, is to conserve "*Hexagona* Fr. *Epicr.* (1836–8) 496 [non *Hexagonia* Poll. Pl. nov. (1819) 35]—type: *H. apiaria* Fr. l.c. 497" against "*Scenidium* [Klotzsch, *Linnaea*, VII (1832) 200, subgen.] O. Kuntze *Rev.* II (1893), 515".

The date of Pollini should have been 1816 and that of O. Kuntze 1898. It is necessary to consider also the genus *Favolus*, since, as will be seen, the nomenclature of these two genera has been much confused. Most mycologists at the present time accept the two genera in the sense of Saccardo's *Sylloge*, VI. *Hexagonia* or *Hexagona* (the spelling varies) is used for corky or woody fungi of polyporaceous affinity which have large, more or less hexagonal pores, resembling the cells of a honeycomb. *Favolus* on the other hand is applied to fleshy or membranaceous species, which also have rather large, polygonal pores, but in which the pores are as a rule elongated radially, so that there is a suggestion of anastomosing lamellae.

Favolus Pal. ex Fr. *Syst. Orb. Veg.* 76 (1825).

The genus *Favolus* was first proposed by Palisot de Beauvois in his *Flore d'Oware et de Benin*, I, tab. I (1805), and was defined as follows: "Substantia coriacea, suberosa, latere sessilis aut subsessilis, subtus plicata: Plicis subregularibus, plerumque hexagonis, alveolatim reticulatis, apium favum simul imitantibus." Only one species was mentioned at that time, *F. hirtus* Pal., which is therefore the type of the genus. This species is of woody consistency and belongs to the later genus *Hexagona* Fr. For this reason, Murrill, in the *North American Flora*, transferred all the species of *Hexagona* to *Favolus* and vice versa (see also below under *Hexagonia* Poll.). Later, in 1809 and 1819? (for dates of the parts of Palisot's *Flore* see *Proc. Amer. Phil. Soc.* LXXVI, 918, 1936), Palisot added the species *F. tenuiculus* and *F. glaber*, of which the former is a *Favolus* as now understood. In 1825 (*Syst. Orb. Veg.* 76) Fries took up Palisot's genus in the mixed sense, including species of both *Hexagona* and *Favolus*, but in 1828 (*Elenchus*, I, 44) he limited the genus *Favolus* to non-woody species, thus excluding Palisot's type, and cited as example *F. brasiliensis* Fr. By so doing he in effect created a genus *Favolus* of his own, with type *F. brasiliensis*. *Favolus* Fr. (1828) was taken up by Saccardo and is used by most mycologists.

Hexagonia Pollini *Horti et provinciae veronensis plantae novae*, 35 (1816).

Pollini's genus, defined as "Pileus subtus in cellulas hexagonas exfossus", was based on the single species *Hexagonia Mori* Poll., which is now regarded as a synonym of *Favolus europaeus* Fr.

Hexagona Fr. *Epicrisis* 496 (1836–8).

Fries attributed the genus *Hexagona*, spelt without an *i*, to Pollini, and included Pollini's type species, *Hexagonia Mori*, which he did not know. The majority of the species listed by him, however, of which the first was *H. Wightii* (Kl.) Fr., were polyporoid forms with more or less woody texture. He kept *Favolus* distinct, and mentioned that both *Hexagona* and his *Favolus* were included by Palisot under *Favolus*.

Scenidium (Kl.) O. Kuntze *Rev. Gen. Pl.* III, ii, 515 (1898).

Scenidium was a name proposed by Klotzsch in *Linnaea*, VII, 200 (1832) for a "tribe" of *Polyporus*, characterized by having seta-like growths on the pore walls. The type was *Polyporus Wightii* Kl., but Klotzsch never used *Scenidium* as a generic name and made no combinations. In 1898 Kuntze pointed out that *Hexagona* Fr., was not the same as Pollini's genus *Hexagonia*, since the type of the latter, *H. Mori*, was a species now regarded as belonging to *Favolus*. He therefore maintained that Fries's genus should be renamed, and for this purpose raised Klotzsch's tribe *Scenidium* to generic rank. The name has not been used by any later mycologist.

Discussion.

Since according to our present Rules the nomenclature of the Hymenomycetes begins with Fries, *Syst. Mycol.* I (1821), there is no need to conserve *Hexagona* Fr. against the later *Scenidium* (Kl.) O. Kuntze. There remains, however, the question of the spelling, *Hexagonia* or *Hexagona*. *Hexagonia* has been used by Saccardo, *Syll. Fung.* VI (1888); McAlpine, *Australian Fungi* (1895); Killermann in Engler & Prantl, *Nat. Pflanzenfam.* ed. 2, VI (1928); Clements & Shear, *Genera of Fungi* (1931). On the other hand *Hexagona* has been used by Lloyd, *Syn. Gen. Hexagona* (1910); Bourdot & Galzin, *Hyménomycètes de France* (1928); Shope, *Polyporaceae of Colorado* (1931); Konrad & Maubl. *Icon. Sel. Fung.* (1924–37).

Although the omission of the *i* by Fries may have been an unintentional error, as stated in the examples under Art. 70 of the Rules, it would appear desirable to adopt this spelling in order to emphasize that the genus as at present understood is not based on the plant to which Pollini gave the name *Hexagonia*. If the first species from Fries's first section be chosen as lectotype, his conception of the genus will be preserved. *Hexagona Wightii* (Kl.) Fr. (non *Wrightii*) is therefore suggested as lectotype; this species is probably identical with *Polyporus apiarius* Pers., the species suggested as type in the published proposal.

Recommendation. It is recommended that the proposal to conserve *Hexagona* Fr. (1836–8) against *Scenidium* (Kl.) O. Kuntze (1898) be rejected as unnecessary. It is further recommended that the name of the genus be spelt *Hexagona*, not *Hexagonia*, and that *H. Wightii* (Kl.) Fr. be chosen as lectotype.

Agaricus Linn. ex Fr. (1821) versus Psalliota (Fr.) Quél. (1872) and Pratella (Pers.) S. F. Gray emend. Gill. (1874)

The proposal published in the Supplement to the *International Rules*, 1930, is to conserve *Agaricus* Fr. *Syst. Mycol.* I (1821), 8, emend. Karst. *Hattsv.* I (1879), 482 against *Psalliota* Quél. *Champ. Jura et Vosges*, I (1872), 107 and *Pratella* Gill. *Hym. France* (1874), 559.

The converse proposal, to conserve *Psalliota* Quél. against *Agaricus* Fr., was made by the late Professor Jaczewski in a list which was sent in too late for inclusion with the other proposals in the Rules. It was published by Briquet in his *Rec. Syn.* 1930, p. vii.

Agaricus Linn. ex Fr. *Syst. Mycol.* I, 8 (1821).

The name *Agaricus* was taken up by Fries in the sense of Linnaeus, *Sp. Plant.* ed. 1, 1753, but was confined by him to fleshy gill-fungi, whereas Linnaeus had included certain more or less woody species.

Fries divided *Agaricus* into a number of "tribes", which have since been used as genera and are frequently attributed to him in this rank, though illegitimately. Quélet (loc. cit.) seems to have been the first to use the Friesian sections as genera. Now Art. 51 of the Rules lays it down that when a genus is divided into two or more genera, the generic name must be retained for one of them, or (if it has not been retained) must be re-established. The genus for which it is retained must be that which contains the original type species, or a lectotype, which must be chosen. According to the Rules therefore the name *Agaricus* should have been retained for something, but its application must be decided according to what is selected as the type species of *Agaricus* Linn. ex Fr.

The name *Agaricus* goes back to early times, and was applied to woody fungi such as *Daedalea quercina* and *Fomes officinalis*, but this need not be considered. Linnaeus (loc. cit.) defined *Agaricus* and divided it into two sections, the first, with twenty-four species, containing the fleshy stipitate Agarics, and the second containing three dimidiate species, namely the fungi now known as *Daedalea quercina*, *Lenzites betulina*, and *Schizophyllum commune*. In Fries's classification only the first of these sections was included in *Agaricus*, so that it is advisable to select as type of *Agaricus* Fr. (1821) a species which Linnaeus included in the first (stipitate) section. *Agaricus campestris* may be selected as lectotype. It is common, is of economic importance, and was known from very early times. If this is done, then *Agaricus* becomes the valid name, according to the Rules, for the genus which includes *A. campestris* Linn.

In this sense *Agaricus* has been used by Karsten, *Hattsv.* I, xxv and 482 (1879); Saccardo, *Syll. Fung.* v, 993 (1887) and *Flora Ital. Crypt.* I, Fasc. 15 (1916); Massee, *British Fungus Flora*, I, 409 (1892); Patouillard, *Hym. d'Europe*, 121 (1887) and *Essai Taxon.* 173 (1900); Konrad et Maubl., *Icon. Sel Fungor.* (1924–37); R. Singer, "Das System der Agaricales" in *Ann. Mycol.* XXXIV, 340 (1936); also by Murrill in various papers in *Mycologia*, etc.

Pratella (Pers.) S. F. Gray (1821) emend. Gillet, *Hyménomycètes* (1874).

Pratella was used by Pers. *Syn.* (1801) as the name of a section of *Agaricus* which contained both purple- and brown-spored forms. It was first used as a generic name by S. F. Gray, *Nat. Arr. Brit. Plants*, I, 626 (1821), who included various purple-spored agarics (e.g. *Psalliota*, *Hypholoma* and *Stropharia* spp.). Gillet (loc. cit.) limited *Pratella* to the mushroom genus. The name has not been used by any recent mycologist.

Psalliota (Fr.) Quél. *Champ. Jura et Vosges*, I, 107 (1872).

Fries used the name *Psalliota* as that of a tribe or subgenus for the group of purple-spored agarics including *Agaricus campestris*. Quélet in 1872 (loc. cit.) dropped the name *Agaricus* entirely, and elevated all the subgenera of Fries to the rank of genus. He has been followed in the use of *Psalliota* by Kauffmann, *Agaricaceae of Michigan*, 232 (1918); Ricken, *Die Blätterpilze*, 235 (1915); Rea, *British Basidiomycetae* (1922); Ramsbottom, *Handbook of the Larger British Fungi* (1923); Lange, *Flora Agaricina Danica*, IV, 53 (1939); Buller, *Researches on Fungi* (1909–34); Bisby *et al.*, *Fungi of Manitoba and Saskatchewan* (1939). Further, the more recent editions of certain textbooks, such as Strasburger, *Textbook of Botany*, and Scott, *Structural Botany*, have adopted *Psalliota* in place of *Agaricus* of the earlier editions for the name of the common mushroom. The *Review of Applied Mycology* has used *Psalliota* for the past ten years.

Discussion.

There is no doubt that the name *Agaricus*, according to the current Rules, ought to have been retained when the group was divided, and there seem to be good reasons for applying it to the genus containing *Agaricus campestris* Linn. ex Fr., which may be chosen as lectotype. On the other hand, chiefly owing to the use of works such as Ricken's *Blätterpilze* and Rea's *Basidiomycetae*, the name *Psalliota* has come into very general use in recent years, and is now found even in academic

textbooks. Rea uses the name *Psaliota*, but the current edition of Liddell & Scott gives ψαλλιον as the preferable Greek form; from this it would seem that *Psalliota* is the better spelling. It is open to question if it is advisable to insist on the use of the valid name *Agaricus*.

Recommendation. The majority opinion of this committee is that *Agaricus* should be typified by *Agaricus campestris* Linn. ex Fr. *Agaricus* Linn. ex Fr., with the date from 1821, will then be the valid name for the genus that includes the common mushroom, and need not be conserved against either *Psalliota* (Fr.) Quél. (1872) or *Pratella* (Pers.) S. F. Gray emend. Gillet (1874).

Septoria Sacc. (1884) versus *Septoria* Fr. (1828)

The proposal published in the Supplement to the *International Rules*, 1935, is to conserve *Phleospora* Wallr. *Crypt. Germ.* 176 (1833) against *Septoria* Fr. *Syst. Mycol.* III, 480 (1832), emend. O. Kuntze, *Rev. Gen. Pl.* III, ii, 520 (1898). Actually, however, Kuntze employed not *Septoria* but *Septaria* Fr., *Nov. Fl. Suec.* v, 78 (1819), the name which Fries first used with *S. Ulmi* as type.

Septoria Fr. *Syst. Myc. Elenchus*, II, 117 (1828).

Valid publication of this genus dates from 1828 when Fries (loc. cit.) spelt the name with an *o* and listed three species, *S. Ulmi*, *S. Oxyacanthae* and *S. Fraxini*. *Septaria* Fr. is therefore an orthographic variant of *Septoria* Fr. the valid name.

In 1832 (*Syst. Mycol.* III, ii, 480) Fries described *Septoria* again and observed that the spores may be borne in "perithecia" (pycnidia) or not. He did not list any species this time but noted that Desmazières had added two species, *S. Rosae* Desm. and *S. Heraclei* Desm. The former is a pycnidial form. Fries's previously mentioned species, *S. Ulmi*, *S. Oxyacanthae* and *S. Fraxini*, do not have pycnidia.

Phleospora Wallr. in *Fl. Crypt. Germ.* 176, 1833.

This genus was described with two species, *P. Ulmi* and *P. Oxyacanthae*, and is therefore a synonym of *Septoria* Fr. 1828.

Septoria Sacc. *Syll. Fung.* III, 474 (1884) non Fr.

Saccardo (*Michelia*, II, 6 (1880)) recognized four sections of *Septoria* Fr. Of these one was *Euseptoria* "Perithecia distincta; spermatia angustissima.—Ex. *S. Crataegi* Kx., *S. Cytisi* Desm.", and another was *Phleospora* Wallr.—"Perithecia obsoleta; spermatia crassiora.—Ex. *S. Ulmi* Fr., *S. Oxyacanthae* Kunze".

In 1884 (loc. cit.) he restricted the use of the name "*Septoria* Fr." to his own section, *Euseptoria*, i.e. for species that form definite pycnidia, and raised *Phleospora* Wallr. to generic rank again to take the non-pycnidial species.

Although complete unanimity does not exist even to-day about the use of the name *Septoria*, yet most modern mycologists employ this large and economically significant genus in Saccardo's way: Grove, *J. Bot., Lond.*, LVII, 206–8 (1919) and *Br. Stem and Leaf Fung.* I, 365 (1935); Allescher in Rabenhorst, *Kryptogamen-Fl. Deutschl.* I, vi (1), 704 (1901); Potebnia, *Ann. Mycol.* XIII, 64 (1910); Clements & Shear, *Genera of Fungi*, 368 (1931); Diedicke, *Ann. Mycol.* X, 484 (1912) and *Kryptogamen-Fl. Mark Brandenburg*, IX, vii, 421 (1915); Migula, *Kryptogamen-Fl. Deutschl.* III, iv (1), 374 (1921). With the exception of the last two, who distribute the non-pycnidial species among Melanconiaceous genera, *Cylindrosporium* Unger, *Septogloeum* Sacc., etc., these writers employ *Phleospora* for the forms with incomplete pycnidia.

O. Kuntze (loc. cit.) adopted *Septaria* Fr. (1819) based on *S. Ulmi* Fr. for the non-pycnidial species compiled by Saccardo under *Phleospora* and transferred all the species which Saccardo includes under *Septoria* to *Rhabdospora* Dur. & Mont. He has no following.

The name *Septoria* has thus been used in three different ways:

(1) For non-pycnidial forms as when it was founded by Fries with *S. Ulmi* Fr. as type and again when Kuntze restored it. In this sense *Phleospora* Wallr. is an exact synonym of it.

(2) For both non-pycnidial and pycnidial forms, as expanded by Fries himself in 1832 and followed by other authors.

(3) For pycnidial forms only, as it was emended by Saccardo in 1884. Since, however, this excludes Fries's type species, it cannot now be accepted as an emendation of his genus and if its use is to be continued it must be accepted as a new genus *Septoria* Sacc. and be conserved against its earlier homonym *Septoria* Fr.

Recommendation. As the genus *Septoria* Fr. was based originally on a non-pycnidial species (*S. Ulmi*), was then expanded to take both non-pycnidial and pycnidial species, and was later reduced by Saccardo in 1884 to include only pycnidial species; and as in later years this latter use has overwhelmingly prevailed, it is recommended that Saccardo's use of *Septoria* be attributed to Saccardo himself, and that *Septoria* Sacc. (1884) with type species *S. Cytisi* Desm. be conserved against *Septoria* Fr. (1828).

Phleospora Wallr. (1833), which was based on non-pycnidial species (*P. Ulmi* and *P. Oxyacanthae*) and is an exact synonym of *Septoria* Fr. (1828), will then become available for non-pycnidial species.

If *Septoria* Sacc. is united with *Phleospora* Wallr. (=*Septoria* Fr.), the earliest name for the aggregate genus, i.e. *Septoria* Fr., must be adopted, in accordance with Art. 21, note 3, and Art. 56 of the *International Rules*.

Ramularia Sacc. (1880) versus *Ramularia* (Ung.) Corda (1842)

The published proposal is to conserve *Ramularia* Fresen. in *Beitr.* 88 (1863), Sacc. in *Michelia*, II, 20 (1880), non Unger, *Exanth.* 169 (1833)—type *R. lactea* [Desm. in *Ann. Sci. Nat.* (3), XIV, 109 (1850), sub *Fusisporio*] Sacc. in *Michelia*, II, 549 (1881)—against *Cylindrospora* Schroet. in *Pilz. Schles.* II, 485 (1897) ex Grev.

Ramularia (Ung.) Corda *Icon. Fung.* V, 7 (1842).

Unger (in 1833, loc. cit.) described and figured two species of *Ramularia*, *R. pusilla* and *R. didyma*, but gave no generic diagnosis. Under the present Rules, a generic name unaccompanied by a generic diagnosis can only be accepted as validly published if the proposed genus is founded on a single species (Art. 43) and therefore *Ramularia* was not validly published by Unger. The name was, however, validly published when Corda (*Icon. Fung.* V, 7 (1842)) gave a generic diagnosis based on *R. pusilla* (which has non-septate conidia); since when the genus may properly be cited as *Ramularia* (Ung.) Corda. Corda (*Icon. Fung.* V, 9) excluded Unger's second species (which has uni-septate conidia) and made it the type of his own genus *Didymaria*. Later, both Cesati and Fresenius (loc. cit.) described species of *Ramularia* with several septate spores but they did not re-define Corda's genus.

Ramularia Sacc. *Michelia*, II, 20 (1880).

In 1880 Saccardo (loc. cit.) claimed to emend "*Ramularia* Ung.", basing the description on *R. Urticae* Ces. and *R. Cynariae* Sacc. (which have pluriseptate conidia) and at the same time he erected the genus *Ovularia* (*Michelia*, II, 17) for species with non-septate conidia. The next year he transferred *R. pusilla* to *Ovularia* (*Michelia*, II, 170).

Over 400 species of *Ramularia* have been compiled in *Ramularia Sylloge*, and this number has been, and is still being added to. As Saccardo's conception of *Ramularia* has been generally accepted it would be convenient to attribute the "emended genus" to him. *Ramularia* Sacc. can then be conserved against *Ramularia* (Ung.) Corda, of which *Ovularia* Sacc. is a synonym.

The reason for suggesting *R. lactea* as the type is obscure. Cesati appears to have been the first to use *Ramularia* in the sense of Saccardo and it is therefore proposed that, following the suggestion of Clements & Shear, *R. Urticae* Ces., the earliest of the two species on which Saccardo founded his genus, be adopted as the type.

Cylindrosporium Grev. *Scot. Crypt. Flor.* 1, no. 27 (1823).

Greville in 1823 (loc. cit.) founded the genus *Cylindrosporium* on the single species *C. concentricum*, the non-septate spores of which are extruded through the epidermis of the host. A genus founded on this species cannot clash with *Ramularia* of Saccardo. Unger in 1833 (*Exanth.* 166) used Greville's genus under the orthographic variant *Cylindrospora* to cover diverse elements. In 1897 Schroeter (loc. cit.) adopted "*Cylindrospora* Grev." to replace *Ramularia* in the sense of Saccardo. As this excluded Greville's type species, Schroeter's use is now invalid and as the thirty-eight binomials he proposed have not been taken up it is neither necessary nor useful to propose a genus "*Cylindrospora* Schroet." and conserve it against *Cylindrosporium* Grev.

Recommendation. As *Ramularia* of Saccardo's use has been almost universally accepted by mycologists and plant pathologists it is recommended that the genus be attributed to him, and that *Ramularia* Sacc. (1880), type species *R. Urticae* Ces., be conserved against *Ramularia* (Ung.) Corda (1842).

(*Accepted for publication* 29 *June* 1940)

LIST OF BRITISH USTILAGINALES

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Introduction

The list of British Ustilaginales is the second of the lists of British Fungi to be completed in accordance with the recommendations of the Plant Pathology Committee, already noted in these *Transactions* (xxiv, 1940, p. 126).

Little taxonomic work has been done on the British Ustilaginales during the present century, and Plowright's monograph published in 1889 remains the standard work. This volume contains descriptions of forty-nine species, excluding those no longer recognized as smuts. Massee (1913), in a book based on Plowright's monograph, gave a number of additional hosts which are not all derived from British records.

The seventy names appearing in this list are arranged alphabetically under the three families, Ustilaginaceae, Tilletiaceae and Graphiolaceae. Occasionally, for example, the smuts of Scabious and the members of the genus *Entorrhiza*, where references could not be separated satisfactorily from internal evidence, the fungi are placed collectively under one specific name. A few obvious errors have been corrected by the examination of herbarium material, but the work is based mainly on the records and must be accepted as such. The references which are given to a few standard works indicate where changes in nomenclature have been proposed.

In the Ustilaginales many of the changes in the specific epithet arise from divergent views as to the best method of classifying physiologic forms. In this group, more than in any other, the tendency has been to give such forms specific rank. Up to a point this procedure aided diagnosis, as it often linked only one angiospermic genus with a particular species of smut, but the results of more intensive work, so far conducted on a few species only, suggest that both host and pathogen comprise a complex network of biotypes and that the limits set by the classificatory units of higher plants are not strictly followed by the fungus as, for example, in *Ustilago Kolleri*, where a physiologic form (C 2/2), which is homozygous for pathogenicity, can infect both *Avena sativa* and *A. strigosa*, species of oats which belong to two different chromosome groups. The interrelations of physiologic forms can be determined only by a long series of experiments, and it seems that an essential attribute of any system for cataloguing them is elasticity. This is provided in numerals, combined with trinomials where the

groups are large and well defined, as in the classic example of *Puccinia graminis*.

It has been argued (Huxley, *The New Systematics*, 1940, 4), that species are "distinct self-perpetuating units with an objective existence in nature", and that speciation is more than a convenient catalogue. The comparatively recent discovery of sexuality in the Ustilaginales, with attendant problems of crossing and sterility, makes it no longer impossible to view speciation from such an angle in this group. This is, however, a matter for the future. Data will be needed, not only on the number of physiologic forms and their distribution in nature, but also on their potential and actual ability to cross. Correlations should be examined between physiologic specialization and minute morphological and physiological characteristics. Not only host specialization, but the whole range of variability within and beyond the limits of an accepted species must come under review. In my opinion, weighting each physiologic form with a binomial and an authority only tends to obscure genetic relationships, and does nothing to clarify the species concept.

Acknowledgements

The work of compiling the list was done for the most part in the Herbarium of the Royal Botanic Gardens, Kew, and the writer is deeply indebted to Sir Arthur W. Hill and to Mr A. D. Cotton for this hospitality. Special thanks are given to Miss Wakefield, Dr G. R. Bisby, Dr G. C. Ainsworth, and Mr W. C. Moore for their helpful advice and material aid in checking records. Grateful acknowledgement is made of the valuable assistance rendered by those members of the Society who searched periodicals and prepared the requisite cards.

USTILAGINACEAE

Cintractia Caricis (Pers.) Magn. Sowerby as *Farinaria carbonaria* **42**, t. 396, f. 4, 1803, on *Carex Micheliana*; **51**, 443, 1824 as *Uredo urceolorum*; **58**, 204; **20**, 375; **19** (2, v, 463, No. 479, 1850) as *Ustilago Montagnei* on *Rhynchospora alba*; **18**, 335; **52**, 203; **15**, 513 as *U. urceolorum*; **65** (xi, 469) on *Scirpus caespitosus* in Forfarshire; **13**, 253; **10**, 276 as *U. Caricis* on *Carex* and *Rhynchospora*; **9**, 174; **71** (xxviii B, 137); **50**, 188; **27** (lx, 168) as *Cintractia sub-inclusa* on *Carex riparia*. On *Carex* and *Rhynchospora*.

Lindau (1914) 33 as *C. Caricis* on *Carex* and *Rhynchospora*; Clinton (1904) 401 and 398. Schellenberg (1911) 74, and Bubák (1916) 29 and 30 use the name *C. Montagnei* (Tul.) Magn. for the smut on *Rhynchospora* and *C. Caricis* (Pers.) Magn. for that on *Carex*; Liro (1938) and others have subdivided the species still further; Ciferri (1938) 254. The smut on *Scirpus* is sometimes regarded as distinct (Schellenberg (1911) 77 and Liro (1938) 43).

— **patagonica** Cooke & Massee in **14** (xviii, 34, 1889), type from Patagonia; **56** (xxvii, p. cxcvii, 1903), on *Bromus unioloides* from seed from Patagonia; **31** (xxxiii, 14, 1903); **28** (iv, 330); **50**, 203. On *Bromus unioloides*.

Clinton (1904) 349 gives this as a synonym of *Ustilago bromivora* (Tul.) Fisch. v. Waldh.

Sorosporium Saponariae Rudolphi. Southwell **14** (x, 67, 1881) as *Ustilago Rudolphi* in ovaries of *Dianthus deltoides* in a garden, Norwich; **10**, 296 as *Sorosporium Saponariae*; **9**, 202; **56** (xxvi, 651 and 654); **56** (xxvii, 31); **50**, 203. On Caryophyllaceae.

Schellenberg (1911) 160; Lindau (1914) 36; Bubák (1916) 33. Liro (1938) 61 as *Sorosporium purpureum* (Hazsl.) Liro; Ciferri (1938) 239 as *S. Saponariae* on *Saponaria officinalis*, some forms on other members of the Caryophyllaceae are given different specific names.

Sphacelotheca Hydropiperis (Schum.) de Bary. Cooke **52** (4th ed., 229, 1878) as *Ustilago Candollei*, in ovaries of *Polygonum Hydropiper* and other species of *Polygonum* **14** (v, 57, 1876 and p. 100); **81**, 262; **10**, 282 as *S. Hydropiperis*; **9**, 181; **50**, 200; **71** (xlii, B, 4, 49); **70** (xxi, N.S. 395). On *Polygonum*.

Clinton (1904) 394; Schellenberg (1911) 65; Lindau (1914) 35; Liro (1924) 2; Bubák (1916) 28; Ciferri (1938) 278.

— **inflorescentiae** Trel. Wilson **28** (ix, 143, 1924). In bulbils of *Polygonum viviparum*, Perthshire, 1914 and 1921. On *Polygonum viviparum*.

Clinton (1904) 383 as *Ustilago Bistortarum* var. *inflorescentiae* Trel.; Schellenberg (1911) 69 as *Sphacelotheca Polygoni-vivipari* Schellenb.; Liro (1924) 7 as *Ustilago ustilaginea* (DC.) Liro; where the generic position of this fungus is discussed, p. 165. Ciferri (1938) 273 as *Sphacelotheca ustilaginea* (DC.) Cif.

Sphacelotheca Reiliana (Kühn) Clinton. Cooke **89**, 236, 1906 as *Ustilago Reiliana* on maize. On *Zea Mays*.

Clinton (1904) 393; Bubák (1916) 27; Ciferri (1938) 267 as *Sphacelotheca Holci-Sorghi* (Rivolto) Ciferri.

Thecaphora seminis-Convolvuli (Desm.) Liro. Berkeley & Broome **19** (3, xviii, 121, No. 1148, 1866) as *T. hyalina* Fingerhuth, in capsules of *Convolvulus* **19** (4, vii, 731, No. 1310, 1871) recorded near Bath and in some other *Soldanella* at King's Lynn; **52** (4th ed., 231); locality; **14** (ii, 186) on fruit of *C. sepium*; **14** (v, 73); **10**, 296; **9**, 200; **50**, 202, on *C. arvensis*. On *Convolvulus*.

Schellenberg (1911) 156 on *C. arvensis*; Lindau (1914) 38 and Bubák (1916) 37 as *Thecaphora capsularum* (Fr.) Desm. on *C. arvensis* and *C. sepium*; Liro (1938) 59 *T. seminis-Convolvuli* (Duby) Liro on *C. arvensis*; Ciferri (1938) 230 *T. hyalina* on *C. sepium* and *C. Soldanella*, 234 *T. Passeriniana* (Cocconi) Cif. on *C. arvensis*.

— **Lathyri** Kühn. Drummond **28** (ix, 144, 1924) in seeds of *Lathyrus pratensis* L. near Edinburgh 1923. On *Lathyrus pratensis*.

Schellenberg (1911) 158 and Bubák (1916) 37 as *T. deformans* Dur. & Mont.; Liro (1938) 58 and Ciferri (1938) 233 as *T. Lathyri*.

— **Trailii** Cooke. Trail **14** (xi, 155, 1883); **40** (vii, N.S. i, 85, 1883) on *Carduus heterophyllus*, Scotland; **40** (viii, N.S. ii, 228); **10**, 296; **9**, 201; **50**, 202. On *Carduus*.

Ustilago Avenae (Pers.) Jens. Kirby **45** (v, 112, 1800) as *Reticularia segetum* in experiments on control; **55** (ii, 704, 1817); **92**, 15 as *Uredo segetum*; **120**, 538 as *Ustilago segetum* on the deformed glumes of grasses; **20**, 374; **51**, 442 as *Reticularia segetum*; **58** (ii, 203); **15**, 512 as *Ustilago carbo*; **40** (iii, 309); **18**, 335 as *U. segetum*; **52**, 202, 1865; **13**, 252; **81**, 254 as *U. carbo*; **65**, 488 as *U. segetum*; **9**, 172; **10**, 273 as *U. segetum*; **71** (xxviii, B, 137) as *U. Avenae*; **71** (xl, B_2, 49). Control and incidence on oat varieties **23** (ii, 323, 1895; xx, 799; xxiv, 1417; xxv, 1486); **25** (ii, 426; xxvi, 202; xxxii, 74 and 234); **49** (iv, 110); **79** (i, 28; v, 24; xi, 43); **24** (i, 14; ii, 222; iii, 42 and 198; vi, 220; xx, 52); **26***a* (Ser. C, No. 1, 28, 1921; Ser. C, No. 3, 46); **34** (xix, 462); **22** (No. 21, 11, 1918; No. 33, 30; No. 38, 16; No. 52, 14; No. 70, 12; No. 79, 15); biochemistry in **66** (ccxx, B, 99); biology in **34** (xii, 314); **34** (xv, 586; xvi, 65; xx, 258; xxiii, 245. On *Avena*.

Bubák (1916) 15; Lindau (1914) 19; Clinton (1904) 344; Schellenberg (1911) 6; Liro (1924) 98; Ciferri (1938) 285.

Ustilago Bistortarum (DC.) Koern. Cooke **14** (v, 118, 1877) as *Tilletia bullata* on leaves of *Rumex obtusifolius*, Glasgow, collected by Paterson*; **52** (4th ed., 233); **81**, 253; **10**, 277 as *Ustilago Bistortarum* on *Polygonum Bistorta* and *Rumex?* sp., **9**, 175; **50**, 193; **28** (IX, 143) on leaves of *Polygonum viviparum*, Perthshire. On *Polygonum*.

Two leaf smuts of *Polygonum* are sometimes recognized, *U. pustulata* (DC.) Wint. and *U. marginalis* (DC.) Lév.; see Bubák (1916) 17; Liro (1924) 9 and 11; Ciferri (1938) 364 and 367. Clinton (1904) 382 and Lindau (1914) 28 give *U. Bistortarum*; Schellenberg (1911) 35 and 38 refers to two species under the names *U. Bistortarum* and *U. marginalis*.

— **bromivora** (Tul.) Fisch. v. Waldh. **31** (VIII, 19, 1877) on *Bromus mollis* near Kilburn; **52** (4th ed., 230); **10**, 278 on *Bromus secalinus* and *B. mollis*; **9**, 175 on species of *Bromus*; **23** (III, 289); **50**, 190; **22** (No. 52, 42). On *Bromus*.

Clinton (1904) 349; Schellenberg (1911) 18; Lindau (1914) 22; Bubák (1916) 13; Ciferri (1938) 297. Liro (1924) 91 gives specific rank to three physiologic forms of this smut. G. W. Fischer (*Mycologia*, XXIX, 408, 1937) considers that it is indistinguishable morphologically from the ear smuts of some other grasses and unites them under the name *U. bullata* Berk.

— **Cardui** Fisch. v. Waldh. Cooke **52** (4th ed., 231, 1878); **10**, 282 on *Carduus acanthoides*; **9**, 181; **50**, 190 in the ovaries of *C. acanthoides* and *C. nutans*. On *Carduus*.

Schellenberg (1911) 46; Bubák (1916) 24; Lindau (1914) 32; Liro (1924) 55; Ciferri (1938) 392.

— **grandis** Fr. Berkeley & Broome **19** (2, v, 463, No. 480, 1850) as *Ustilago Typhoides* on the stems of *Arundo Phragmites* (*Phragmites communis*), Fens of Cambridgeshire; **18**, 335; **52**, 203; **15**, 513 as *U. grandis*; **81**, 252; **10**, 275; Massee **9**, 173 and **50**, 192 gives as hosts *Typha latifolia* and *T. minor* (probably in error, see Liro 1924, p. 406). On *Phragmites communis*.

Schellenberg (1911) 22; Bubák (1916) 11; Lindau (1914) 20; Liro (1924) 82; Ciferri (1938) 322.

— **Hordei** (Pers.) Lagerh. See under *U. Avenae* for records up to 1889. Plowright **31** (v, 375, 1889) as *U. tecta*; **56** (XIII, 116); **71** (XL, B_2, 49) as *U. Hordei*; control and incidence on barley varieties in **23** (II, 323, 1895; XXIV, 1388 and 1417; XXV, 1486; XXIX, 1050); **25** (XXIV, 161, 1924; XXVI, 200; XXVIII, 184; XXIX, 50; XXX, 94; XXXII, 74); **79** (I, 28; V, 24; XI, 44); **80** (XXIII, 20); **24** (XIX, 55; XX, 53); **22** (No. 21, 11, 1918; No. 33, 31; No. 38, 18; No. 52, 16; No. 70, 13; No. 79, 17); **26***a* (Ser. C, No. 3, 46, 1923); hyphal fusions, seedling infection, physiology and genetics in **67** (CI, B, 126, 1927; CII, B, 174; CIII, B, 547); longevity of spores in **34** (XV, 595). On *Hordeum*.

Clinton (1904) 341; Schellenberg (1911) 11; Lindau (1914) 23; Bubák (1916) 10; Liro (1924) 103; Ciferri (1938) 312.

— **hypodytes** (Schlecht.) Fr. Berkeley & Broome **19** (1, VI, 439, No. 256, 1841) on Spittal Links, Berwick; **19** (2, v, 463, No. 481, 1850) on *Bromus erectus* at King's Cliffe; **18**, 335 on stems of various grasses; **14** (v, 100); **52**, 203; **15**, 513; **13**, 252; **10**, 273; Massee **9**, 172 and **50**, 193 includes *Phragmites communis* as host, but Liro (1924) suggests that this record should refer to *U. grandis*; **56** (XVI), XXI, 1894 as species of *Ustilago* (*?U. hypodites*) on *Psamma arenaria* on the east coast; **22** (No. 79, 51); **37** (1936, 17). On Gramineae.

Clinton (1904) 338; Schellenberg (1911) 25; Lindau (1914) 23; Bubák (1916) 11; Liro (1924) 88; Ciferri (1938) 305.

* I have not seen this specimen, but the description given does not tally with *U. Parlatorei* Fisch. v. Waldh. a smut which occurs on dock. Another specimen in the Kew Herbarium labelled *Tilletia bullata* on *Rumex obtusifolius* was found to be *U. Bistortarum* (with marginal sori) and the host was certainly not *Rumex* but was probably *Polygonum Bistorta*. It is doubtful if the Glasgow specimen was on *Rumex*.

Ustilago Kolleri Wille. See under *U. Avenae* for records up to 1889. **5** B, 211 and 401, 1915 as *U. Avenae* var. *levis*; **71** (XL, B_2, 49) as *U. Kolleri*; control and incidence on oat varieties in **23** (XXV, 1486); **25** (XXVI, 202; XXXII, 234); **49** (IV, 110); **26***a* (Ser. C, No. 1, 28, 1921 and Ser. C, No. 3, 46, 1923); **34** (XIX, 462); **22** (No. 38, 16; No. 52, 14; No. 70, 12; No. 79, 15); hyphal fusions, seedling infection, physiology and genetics in **67** (CI, B, 126, 1927; CII, B, 174; CIII, B, 547; CVIII, B, 395); biology in **34** (XII, 314; XV, 586; XVI, 65; XX, 258; XXIII, 245). On *Avena*.

Clinton (1904) 342 as *U. levis*; Schellenberg (1911) 10; Lindau (1914) 19; Bubák (1916) 9; Liro (1924) 101; Ciferri (1938) 289.

— **Kühneana** Wolff. Berkeley **31** (N.S. VI, 15, 1876); **31** (N.S. VI, 45, 1876); **14** (V, 57) on *Rumex Acetosa*; **19** (5, i, 27, No. 1707, 1878) on *R. Acetosella* at Rothamsted; **52** (4th ed., 231, 1878); **81**, 262; **10**, 281; **9**, 180; **50**, 194. On *Rumex*.

Schellenberg (1911) 42; Bubák (1916) 20; Ciferri (1938) 370. Liro (1924) 25 regards the form on *R. Acetosa* as a distinct species, *U. stygia* Liro.

— **longissima** (Sow. ex Schlecht.) Meyen. *Uredo longissima* in Sowerby **42**, t. 139, 1799; **20**, 375, 1836; **55**, 725; **18**, 335 as *Ustilago longissima* on leaves of *Poa* (*Glyceria*) *aquatica*; **52**, 203 1865; **15**, 512; **40** (II, 309) in Moray; **14** (V, 100); **13**, 252; **81**, 260; **10**, 273 on *G. aquatica* and *G. fluitans*; **71** (XXVIII, B, 137); **70** (XXI, N.S. 395). Massee **9**, 171 and **50**, 192 gives *Phalaris arundinacea* as an additional host, but this may refer to *U. echinata* Schroet. On *Glyceria*.

Clinton (1904) 339; Schellenberg (1911) 23; Lindau (1914) 22; Bubák (1916) 12; Liro (1924) 83; Ciferri (1938) 308.

— **major** Schroet. Plowright **10**, 281, 1889 in the anthers of *Silene Otites* near Brandon; **9**, 179; **50**, 191. On *Silene Otites*.

Clinton (1904) 377 as *U. violacea* var. *major* Clint. on *Silene Watsoni*; Schellenberg (1911) 52 as *U. major* Schroet. on *S. Otites*; Lindau (1914) 30; Bubák (1916) 22; Liro (1924) 41; Ciferri (1938) 384 in his subdivisions of *U. violacea*.

— **marina** Dur. d. Maisonn. Cooke **14** (XIV, 90, 1885) on rhizomes of *Scirpus parvulus* at Little Lea, Poole, Dorset; **31** (XXV, 19); **10**, 275; **50**, 194. On *Scirpus*.

Liro (1938) 227.

— **nuda** (Jens.) Rostr. See under *U. Avenae* for records up to 1889. **31** (V, 375, 1889) as *U. nuda*; **71** (XL, B_2, 49, 1931); incidence and control in **23** (II, 323, 1895; XXIV, 1388 and 1417; XXV, 1486); **25** (XXVI, 201); **22** (No. 21, 11, 1918; No. 33, 31, 1919; No. 38, 19, 1922; No. 52, 17; No. 70, 13; No. 79, 17). On *Hordeum*.

Clinton (1904) 345; Schellenberg (1911) 4; Lindau (1914) 24; Bubák (1916) 15; Liro (1924) 107; Ciferri (1938) 316.

— **olivacea** (DC.) Tul. Berkeley **20** (V, 376, 1836) as *Uredo olivacea*; **18**, 335 as *Ustilago olivacea* on seeds of Carices; **52**, 203, 1865; **15**, 513; **10**, 277 on the fruits of *Carex riparia*; **9**, 175; **50**, 188. On *Carex*.

Clinton (1904) 354; Schellenberg (1911) 32; Lindau (1914) 24; Bubák (1916) 32 as *Elateromyces olivaceus* (Bubák) DC.; Liro (1938) 49 as *Farysia Caricis* (DC.) Liro; Ciferri (1938) 248 as *Farysia olivacea* (DC.) Syd.

— **Ornithogali** (Schm. & Kze.) Magn. Mason **35** (1928, 169) at Tadcaster, Yorkshire, on *Gagea lutea* collected by W. G. Bramley; **115**, 42. On *Gagea*.

Schellenberg (1911) 21; Lindau (1914) 26; Bubák (1916) 12; Liro (1924) 114; Ciferri (1938) 350.

— **perennans** Rostr. See under *U. Avenae* for records up to 1889. Smith & Ramsbottom **28** (VI, 374, 1914) on *Arrhenatherum elatius*; **26***a* (Ser. H, No. 1, 67, 1922); **22** (No. 52, 41, 1926; No. 70, 31; No. 79, 50). On *Arrhenatherum elatius*.

Clinton (1904) 343; Schellenberg (1911) 8; Lindau (1914) 20; Bubák (1916) 13; Liro (1924) 95 as *U. decipiens* (Wallr.) Liro; Ciferri (1938) 295 as *U. Holci-Avenacei* (Wallr.) Cif.

Ustilago Scabiosae (Sow.) Wint. *Farinaria Scabiosae* Sowerby in **42**, t. 396, f. 2, 1803 on *Scabiosa arvensis*; **51**, 443, 1824 as *Uredo flosculorum*; **58**, 204; **20**, 379; **18**, 335 as *Ustilago flosculorum*; **52**, 204, 1865; **15**, 515; **14** (IV, 69) as *U. intermedia*; **40** (III, 200); **13**, 253; **40** (V, 234) as *U. Succisae* on *Scabiosa Succisa* at Rannock; **71** (XXVIII, B, 137) as *U. Scabiosae*; **71** (XLII, B, 4, 49) on *Scabiosa Succisa*; Plowright **10**, 279 recognized as distinct *U. Scabiosae* (Sow.) Wint. on *Scabiosa arvensis* and *U. flosculorum* (DC.) Fr. on *S. Columbaria*, *S. arvensis* and *S. Succisa*, giving *U. intermedia* Schroet. and *U. Succisae* Magn. as synonyms of *U. flosculorum*; Massee **9**, 178 and **50**, 191 gives only the one species *U. Scabiosae*. On *Scabiosa*.

An anther smut of *Scabious* has been described under the following names: *Ustilago Scabiosae* (Sow.) Wint. on *Scabiosa* (*Knautia*) *arvensis*; see Schellenberg (1911) 55, Lindau (1914) 31, Bubák (1916) 20, Liro (1924) 51; *U. flosculorum* (DC.) Fr. on *S. arvensis* see Bubák (1916) 21; Liro (1924) 53; *U. intermedia* Schroet. on *S. Columbaria*, see Schellenberg (1911) 57, Bubák (1916) 21; *U. Succisae* Magn. on *S. pratensis*, see Schellenberg (1911) 58, Bubák (1916) 21, Liro (1924) 54.

— **striaeformis** (Westend.) Niessl. *U. Salvei* B. & Br. in **19** (2, v, 463, No. 482, 1850) on leaves of *Dactylis glomerata*, St Margaret's, Guernsey; **18**, 335; **52**, 203, 1865; **15**, 514; **40** (VII, N.S. I, 34, 1883) on leaves of *Holcus* and *Triticum* [*Agropyron*]; **10**, 284 as *Tilletia striaeformis* on *Dactylis glomerata*, *Triticum* [*Agropyron*] *repens*, and *Holcus lanatus*; **9**, 177 and **50**, 192 as *Ustilago Salvei* on leaves of a grass; **37**, 146 as *Tilletia de Baryana* on many grasses; **71** (XXVIII, B, 137) as *Tilletia striaeformis*; **71** (XLII, B, 4, 49) as *Tilletia de Baryana* on *Holcus mollis* and on species of *Agrostis*. On Gramineae.

Clinton (1904) 370; Schellenberg (1911) 33; Lindau (1914) 41; Bubák (1916) 45. The stripe smut on *Triticum* (*Agropyron*) *repens* is sometimes given another name, see *Tilletia Calamagrostidis* Fuck. in Lindau (1914) 43 and *T. aculeata* Ule in Bubák (1916) 45. According to Liro (1924), *U. striaeformis* (Westend.) Niessl is a large collective species. This binomial is retained for the form on *Holcus lanatus*, *Phleum pratense* and some other grasses; *U. Salvei* B. & Br. is used for the stripe smut of *Dactylis glomerata*. Davis (*Phytopathology*, XXV, 810, 1935) finds that American material differs from European and gives the name *U. Clintoniana* Davis to the stripe smut of this grass. Ciferri (1938) 339 uses the name *U. linearis* (Dozy & Molkenboer) Cif. for stripe smut in the widest sense, and gives a number of names to forms of subspecific rank.

— **Tragopogi-pratensis** (Pers.) Rous. Berkeley **18**, 335, 1860, as *U. receptaculorum* on receptacles of goat's beard; **15**, 515; **52**, 204, 1865; **13**, 253 on *Tragopogon* and *Carduus heterophyllus* (perhaps an error, see *U. Cardui*); **10**, 281 as *U. Tragopogi* on *Tragopogon pratensis*; **40** (X, N.S. 4, 369, 1890); **9**, 180 as *U. Tragopogi*; **71** (XXVIII, B, 137); **50**, 190; **22** (No. 70, 40) on Salsify. On *Tragopogon*.

Schellenberg (1911) 46; Lindau (1914) 31; Bubák (1916) 23; Liro (1924) 56; Ciferri (1938) 396.

— **Tritici** (Pers.) Rostr. See *U. Avenae* for records up to 1889. **5** B, 213 and 401, 1899 as *U. Tritici*; **71** (XL, B_2, 49); incidence and control in **23** (II, 321, 1895; XXIII, 638); **25** (XXVI, 204); **79** (III, 23; V, 24; XI, 43); **85** (XLI, 15); **22** (No. 21, 11, 1918; No. 33, 29; No. 38, 12; No. 52, 12; No. 70, 12; No. 79, 12); longevity of spores **34** (XV, 595, 1928). On *Triticum*.

Clinton (1904) 346; Schellenberg (1911) 2; Lindau (1914) 23; Bubák (1916) 16; Liro (1924) 110; Ciferri (1938) 330.

— **utriculosa** (Nees) Tul. Gray, **120**, 538, 1821 on water-pepper (*Polygonum Hydropiper*?); Berkeley 20, 377, 1836 as *Uredo utriculosa*; **18**, 335 as *Ustilago utriculosa* on seeds of *Polygonum*; **52**, 204, 1865; **15**, 514; **13**, 233; **10**, 280; **9**, 178; **50**, 191. On *Polygonum*.

Clinton (1904) 379; Schellenberg (1911) 59; Lindau (1914) 27; Bubák (1916) 18. Liro (1924) 12–20 and 188, and Ciferri (1938) 358–62 subdivide this species on biometrical and physiological grounds.

Ustilago Vaillantii Tul. Massee **14** (xxi, 120, 1893) on the flowers of *Scilla bifolia* at Newry and on *Chionodoxa* at Kew; **31** (xv, 463, 1894); **37** (Add. Ser. v, 165, 1906) on *Chionodoxa Luciliae*; **71** (xxviii, B, 137); **23** (xx, 799); **74** (ix, 5–14) life-history; **57** (viii, 227) on *C. Luciliae* in Scotland; **65** (xxx, 347) on *Scilla*; **22** (No. 52, 88; No. 117, 56 and 60). On *Chionodoxa*, *Muscari* and *Scilla*.

Clinton (1904) 375; Schellenberg (1911) 19; Lindau (1914) 26; Bubák (1916) 14; Liro (1924) 115; Ciferri (1938) 348 on species of *Muscari*, *U. Scillae* Cif. on *Scilla bifolia*.

— **vinosa** (Berk.) Tul. Berkeley in litt. to Tulasne 1847 as *Uredo vinosa*; **19** (2, v, 464, No. 484, 1850), as *Ustilago vinosa* on the swollen receptacles of *Oxyria reniformis* (*digyna*), Forfarshire; **18**, 335; **52**, 204, 1865; **15**, 514; **13**, 253; **10**, 278; **40** (x, N.S. 4, 368); **9**, 176; **50**, 19. On *Oxyria digyna*.

Clinton (1904) 376; Schellenberg (1911) 41; Liro (1924) 28; Ciferri (1938) 356.

— **violacea** (Pers.) Rous. *Farinaria Stellariae* Sow. in **42**, t. 396, f. 1, 1803, on *Stellaria graminea* and *S. Holostea*; **120**, 538, 1821 as *Ustilago violacea* on anthers of Caryophyllaceae; **51**, 443 as *Uredo antherarum*; **20**, 381; **18**, 335 as *Ustilago antherarum* on *Silene*; **52**, 204, 1865; **31** (xxx, 703 and 763); **15**, 515; **13**, 253; **81**, 260; **31** (v, N.S., 662); **10**, 280 as *U. violacea* on the anthers of *Silene*, *Cerastium*, *Stellaria* and species of *Lychnis*; Plowright **56** (xi, p. cxxix, 1889 and xiii, 114–17) on the influence on the development of floral organs in species of *Lychnis*; **56** (xxvi, 651 and 654 and xxvii, 32) on members of the Caryophyllaceae; **50**, 190; **71** (xlii, B_4, 49) on *Silene acaulis*; **70** (xxi, N.S., 395) on *Stellaria uliginosa*, *Lychnis alba* and *L. dioica*; **31** (c, 254) severe attack on carnations. On Caryophyllaceae.

Clinton (1904) 377; Schellenberg (1911) 49; Lindau (1914) 29; Bubák (1916) 22. Liro (1924) separates *U. violacea* into ten or more species chiefly on grounds of physiologic specialization. Ciferri (1938) 376 *U. violacea* (Pers.) Rous. (*sens. lat.*) is divided into a number of subunits.

— **Zeae** (Beckm.) Unger. Berkeley **31** (1850, 675) as *U. Maydis* on maize from Little Canford; **18**, 335; **52**, 203, 1865; **15**, 513; **10**, 278; **9**, 176; **50**, 189; **85** (xxxv, 20) as *U. Zeae* on a fodder crop of maize. On *Zea Mays*.

Clinton (1904) 362; Schellenberg (1911) 28; Lindau (1914) 17; Bubák (1916) 16 as *U. Zeae-Mays* (DC.) Wint.; Ciferri (1938) 335 as *U. mays-zeae* (DC.) Magn.

TILLETIACEAE

Doassansia Alismatis (Nees) Cornu. Trail **40** (vii, N.S. i, 124, 1884) on *Alisma Plantago* (*-aquatica*) Aberdeen; **14** (xii, 99, 1884); **10**, 294; **9**, 196; Setchell in a review of the genus **33** (vi, 3); **50**, 200; Grove **1** (ii, 295) states that the fungus referred to as *Cylindrosporium Alismacearum* Sacc. is a *Doassansia* with germinating spores, the sporidia of which were mistaken for a Hyphomycete. *Sphaeria Alismatis* Currey (*Phyllosticta Curreyi* Sacc.) **45** (xxii, 334, 1859) was given by Setchell **33** (vi, 8) as a synonym of *Doassansia Alismatis*, but it is uncertain, see Grove **1** (i, 53). On *Alisma Plantago-aquatica*.

Clinton (1904) 479; Schellenberg (1911) 124; Lindau (1914) 61; Bubák (1916) 70; Liro (1938) 207; Ciferri (1938) 66.

— **Limosellae** (Kze.) Schroet. Grove **27** (lx, 169, 1922) on leaves of *Limosella aquatica* on the exposed mud of Earlswood Reservoir, October 1921, germination of spores and conjugation of sporidia observed; Setchell **33** (vi, 36, 1892) in a review of the genus. On *Limosello aquatica*.

Liro (1938) 222 as *Burrillia Limosellae* (Kze.) Liro.

— **Martianoffiana** (Thüm.) Schroet. Boyd **28** (iv, 185, 1912) on leaves of a species of *Potamogeton* at Ardrossan, Ayrshire, August 1911. On *Potamogeton*.

Clinton (1904) 482. Setchell **33** (vi, 28, 1892) placed this in the subgenus *Doassansiopsis* which has been since raised to generic rank, see Bubák (1916) 71, Liro (1938) 217, and Ciferri (1938) 71, as *Doassansiopsis Martianoffiana* (Thüm.) Diet.

Doassansia Sagittariae (Westend.) C. Fisch. *Aecidium incarceratum** Berkeley & Broome in **19** (4, xv, 36, No. 1469, 1875) at Bungay on leaves of *Sagittaria*; **10**, 267; **14** (III, 124, 1875) as *Protomyces Sagittariae* on *Sagittaria sagittifolia*; **52** (4th ed., 227, 1878); **10**, 295 as *Doassansia Sagittariae*; **9**, 197; **50**, 200; **28** (XIX, 283) at Wicken Fen. On *Sagittaria*.

Clinton (1904) 478; Schellenberg (1911) 123; Lindau (1914) 61; Bubák (1916) 70; Liro (1938) 209; Ciferri (1938) 69.

Entorrhiza Aschersoniana (Magn.) Lagerh. Trail **40** (VII, N.S., 241, 1884) as *E. cypericola* in tubercules on the roots of *Juncus bufonius* near Aberdeen; **14** (XIII, 47, 1884); *Trans. Nat. Hist. Soc. Glasgow*, N.S., I, XXXI, 299, 1886 on *J. squarrosus* and *J. uliginosus*, Clober Moor and near Thornmill; **10**, 299; **40** (X, N.S., 4, 372) as *E. Aschersoniana* on species of *Juncus*; **9**, 195; Trail, *Ann. Scottish Nat. Hist.*, No. 47, 188, 1903, as *E. digitata* on *J. lamprocarpus*; **33** (XXIV, 520) as *E. cypericola* on *J. bufonis*, *J. articulatus* and *J. lamprocarpus*, structure and experiments on the germination of the spores; **50**, 199 as *E. Aschersoniana*. On *Juncus*.

Several species of *Entorrhiza* have been described (Ferdinandsen and Winge, *Dansk. Bot. Ark.* II, No. 1 (1914)). Trail **40** (X, N.S., 4, 372, 1890) suggested that more than one species occurred in Scotland, but British specimens have never been clearly distinguished on spore characters, merely on tubercle and host. See Schellenberg (1911) 102 and Bubák (1916) 58 under the genus *Schinzia*; Lindau (1914) 64, Liro (1938) 67 and Ciferri (1938) 75 under the genus *Entorrhiza*.

Entyloma Calendulae (Oudemans) de Bary. Trail **40** (VII, N.S., I, 124, 1884) on *Hieracium vulgatum* near Aberdeen; **14** (XII, 99, 1884); **10**, 292; **9**, 193; **50**, 198; **71** (XLII B_4, 49); **79** (X, 39; XI, 54; XIII, 29) on a species of *Calendula* in Cornwall; **22** (No. 79, 100). On Compositae.

Schellenberg (1911) 113; Lindau (1914) 50; Bubák (1916) 52; Liro (1938) 135; Ciferri (1938) 176. Forms on different genera of the Compositae are given specific names.

— **Chrysosplenii** (B. & Br.) Schroet. *Protomyces Chrysosplenii* B. & Br. in **19** (4, xv, 36, No. 1472, 1875) on leaves of *Chrysosplenium oppositifolium* at New Pitsligo; **14** (III, 181, 1875); **40** (IV, 348); **52**, 227, 1878; **13**, 251; **10**, 291 as *Entyloma Chrysosplenii*; **9**, 193; **50**, 198. On *Chrysosplenium*.

Schellenberg (1911) 117; Lindau (1914) 47; Bubák (1916) 51; Liro (1938) 116.

— **Dahliae** Syd. Pethybridge **31** (LXXXIV, 393, 1928) on cultivated Dahlias; **56** (LIV, 332) control; **71** (XLII, B, 49); **79** (XI, 55); **85** (XXXIX, 19); **22** (No. 79, 99). On *Dahlia*.

Liro (1938) 131.

— **Fergussoni** (B. & Br.) Plowr. *Protomyces Fergussoni* Berkeley & Broome in **19** (4, xv, 36, No. 1473, 1875) on leaves of *Myosotis* at New Pitsligo; **13**, 251; **14** (III, 181, 1875); **52** (4th ed., 227); **40** (VII, N.S., I, 128, 1884) as *Entyloma canescens* on *M. arvensis* near Aberdeen; **14** (XII, 99); **10**, 289 as *E. Fergussoni* on species of *Myosotis*; **9**, 190; **50**, 197. On *Myosotis*.

Schellenberg (1911) 113; Lindau (1914) 48; Bubák (1916) 54; Liro (1938) 124; Ciferri (1938) 193.

— **fuscum** Schroet. Phillips & Plowright **14** (XIII, 52, 1884) as *E. bicolor* on leaves of *Papaver Rhoeas* at North Wootton; **10**, 290; **9**, 191; **50**, 197. On *Papaver*.

Clinton (1904) 471; Schellenberg (1911) 111; Lindau (1914) 46; Bubák (196) 51; Liro (1938) 114; Ciferri (1938) 186.

* This binomial has been given as a synonym of *Doassansia Alismatis* (Nees) Cornu, for the reason that some of the Rabenhorst No. 1492 exsiccata were leaves of *Alisma Plantago* (see Setchell **33** (VI, 12, 1892) and Liro (1938) 207). Berkeley and Broome state, however, that *Aecidium incarceratum* occurred on *Sagittaria* and the specimen bearing this name in the Kew Herbarium is a *Sagittaria*.

Entyloma Helosciadii Magn. O'Connor **70** (xxi, N.S., 395, 1936) on *Sium erectum* near Dublin, 1932. This record may refer to *E. flavum* Cif. On *Sium erectum*.

Lindau (1914) 48 on Umbelliferae; Bubák (1916) 52 as *E. Helosciadii* Magn. on *Berula angustifolia* and *Sium latifolium*; Liro (1938) 119 as *E. flavum* Cif. on *Sium erectum* and *E. Helosciadii* Magn. on *Helosciadium nodiflorum*; Ciferri (1938) 205.

— **Matricariae** Rostr. Described as a new species by Trail in Plowright; see **40** (x, N.S., 4, 277,1890) on *Matricaria inodora* near Aberdeen; **10**, 291, 1889; **9**, 192, 1891 as *E. Trailii* Massee; **50**, 197. On *Matricaria*.

Schellenberg (1911) 116; Lindau (1914) 49; Bubák (1916) 53; Liro (1938) 13.

— **microsporum** (Unger) Schroet. Trail **40** (vii, N.S., 228, 1884) as *E. Ungerianum* on leaves of *Ranunculus repens*, and less often *R. acris*; **10**, 291 as *E. microsporum*; **9**, 193; **50**, 198; on species of *Ranunculus*; **71** (xlii, B4, 49); **1** (ii, 296) as *Cylindrosporium Ranunculi* Sacc. among species excluded from the Hyphomycetes. On *Ranunculus*.

Clinton (1904) 471; Schellenberg (1911) 121; Lindau (1914) 46; Bubák (1916) 56; Liro (1938) 107; Ciferri (1938) 196.

— **Ranunculi** (Bon.) Schroet. Berkeley & Broome **19** (4, xv, 36, No. 1471, 1875) as *Protomyces microsporus* on the leaves of *Ranunculus Ficaria* at New Pitsligo associated with conidia; **14** (iii, 181, 1875); **40** (iv, 348); **14** (vi, 73) as *Entyloma Ungerianum*; **13**, 255; **40** (vii, N.S., 228) as *E. Ficariae*; **10**, 290 as *E. Ranunculi*; **9**, 191; **50**, 197; **71** (xxviii, B, 137); **71** (xlii, B4, 49); structure and life history **66** (clxxviii, B, 173–185).

Conidial stage as *Cylindrosporium Ficariae* in Brit. Fung. Fasc. 3, n. 212; **19** (i, i, 263, No. 135, 1838); **13**, 227; **15**, 475 as *Gloeosporium Ficariae*; **1** (ii, 295) as *Cylindrosporium Ficariae* among species excluded from the Hyphomycetes. On *Ranunculus*.

Clinton (1904) 460; Schellenberg (1911) 117; Lindau (1914) 45; Bubák (1916) 50; Liro (1938) 109; Ciferri (1938) 197.

Melanotaenium endogenum (Unger) de Bary. Trail **40** (vii, N.S., 243, 1884) on stems of *Galium verum* near Aberdeen; **14** (xiii, 47, 1884) on *G. Mollugo*; **10**, 293; **9**, 194; **50**, 199. On *Galium*.

Schellenberg (1911) 105; Lindau (1914) 52; Bubák (1916) 48; Liro (1938) 71; Ciferri (1938) 163.

— **cingens** (Beck) Magn. **28** (ii, 6, 1903) as *Cintractia cingens* on stems and leaves of *Linaria vulgaris* at Glyndyfrdwy, Denbighshire; **28** (vi, 331, 1920) as *Melanotaenium cingens* in a review of the genus. On *Linaria vulgaris*.

Schellenberg (1911) 107; Bubák (1916) 48; Liro (1938) 72; Ciferri (1938) 164.

— **hypogaeum** (Tul.) Schellenb. Phillips and Plowright **14** (xiii, 52, 1884) as *Ustilago hypogaea* in the root-stock of *Linaria spuria* at Freshwater, Isle of Wight; **10**, 276; **9**, 174; **50**, 194; **28** (vi, 334). On *Linaria spuria*.

Schellenberg (1911) 108; Bubák (1916) 47.

— **Lamii** Beer in **28** (vi, 331, 1920) on the underground parts of *Lamium album* at Chalfont near Stroud, Gloucestershire. On *Lamium album*.

Liro (1938) 73.

Schroeteria Delastrina (Tul.) Wint. Plowright **31** (vi, 506, 1889) in the fruits of *Veronica arvensis* near Fakenham, Norfolk; **28** (i, 99). On *Veronica*.

Conflicting accounts have been given of the germination of spores in this species. Schellenberg (1911) 162 and Lindau (1914) 66 doubt if the fungus should be classified in the Ustilaginales. Bubák (1916) 59, Liro (1938) 224 and Ciferri (1938) 80 include the genus in the Ustilaginales, recognizing two species, *S. Delastrina* (Tul.) Wint. and *S. Decaisneana* (Boud.) de Toni on different species of *Veronica*.

Tilletia caries (DC.) Tul. **45** (v, 112, 1800). Kirby records experiments with bunt of wheat. Hooker **92** (ii, 16, 1821) as *Uredo caries*; **51**, 443; **58** (ii, 204); **20**, 373; **56** (ii, 109, 1847) germination of spores; *Fusisporium inosculans* Berk.

56 (II, 114, 1847) as a parasite on bunt=the secondary spores of *Tilletia caries*; **18**, 335 as *Tilletia caries*; **52**, 202; **15**, 511; **13**, 255; **81**, 245; **10**, 283 as *T. Tritici*; **9**, 183; **50**, 195 on species of *Triticum*; **25** (XXVI, 202) as *T. caries*; **71** (XXVIII, 137) as *T. Tritici*; incidence and control **31** (1844, 492; 1850, 651); **23** (XXIII, 634; XXVII, 1013; XXXVI, 139); **26** (I, 169; II, 188; III, 180); **79** (IV, 15; V, 36); **78** (1928, 138); **85** (XXIII, 19; XXIV, 150); **34** (XV, 245; XIX, 35); **24** (XVII, 117; XVIII, 59; XIX, 55; XX, 52); **22** (No. 21, 11; No. 23, 17; No. 33, 29; No. 38, 11; No. 52, 12; No. 70, 11; No. 79, 11); **22** (No. 21, 11, 1918) as *Ustilago Secalis* on rye (this record refers to bunted heads of rye collected in Shropshire by Dr A. Roebuck; no specimens are available, *teste litt.* January 1940). The bunt on rye (*Secale*) is sometimes given specific rank as *Tilletia Secalis* (Corda) Kühn, see Liro (1938) 89; **22** (No. 79, 20, 1934) as *T. caries* on rye in experimental plots; effect on host **34** (XIV, 83); effect on incidence of *Puccinia glumarum* **34** (XIV, 105); cytology **33** (XXXV, 399); toxicity **28** (X, 121 and XI, 82). On *Triticum*.

Clinton (1904) 432, Schellenberg (1911) 90, Bubák (1916) 39, and Ciferri (1938) 86 as *T. Tritici* (Bjerk.) Wint.; Lindau (1914) 43 and Liro (1938) 86 as *T. caries* (DC.) Tul.

Tilletia decipiens (Pers.) Koern. Cooke as *T. sphaerococca* **14** (XII, 99, 1883) in ovaries of *Agrostis pumila* (=*A. tenuis* Sibth. dwarfed by the fungus, see **27** (LXXIII, 70, 1935) and **36** (LI, 89)); **10**, 284 as *T. decipiens*; **9**, 184 as *T. separata*; **37** (1899, 150) in a review of the genus; **50**, 195; **36** (LI, 84, 89 and 94) as *T. decipiens* on *Agrostis canina*, *A. tenuis* and *A. stolonifera*. On *Agrostis*.

Schellenberg (1911) 94; Lindau (1914) 42; Bubák (1916) 43; Liro (1938) 80; Ciferri (1938) 96.

— **Holci** (Westend.) Schroet. Plowright **31** (X, 374, 1891) as *T. Rauwenhoffii* in ovaries of *Holcus mollis* near Doncaster; **28** (I, 60); **71** (XXVIII, 137). On *Holcus*.

Bubák (1916) 40; Liro (1938) 79.

— **Menieri** Har. & Pat. Grove **28** (III, 374, 1911) in the ovaries of *Phalaris arundinacea* at Lock Portmore, Antrim. On *Phalaris arundinacea*.

Liro (1938) 82.

Tuburcinia primulicola (Magn.) Bref. C. Wolley Dod **31** (XXII, 248, 1884) as *Urocystis primulicola* in the capsules of *Primula farinosa* in the garden of Edge Hall, Malpas, Salop; **31** (XXII, 268 and 308, 1884); **19** (5, XV, 345, No. 2049, 1885) on *P. farinosa* in Teesdale and Cumberland; **56** (XII, p. liii) as smut on *P. farinosa* in Lancashire; **40** (X, N.S., 4, 370) in the ovaries of *P. vulgaris*, Aberdeen; **10**, 289; **31** (VII, N.S., 558, 1890); **9**, 189; **56** (XIX, p. xxviii) as *Ustilago primulina*, recovery of previously infected plants; **56** (XXVII, 377) as *Urocystis primulicola*; **50**, 205; life history and cytology of *Tuburcinia primulicola* in *Rep. Brit. Ass. Sec. K, Manchester*, 730, 1915; **28** (V, 290). On *Primula*.

Schellenberg (1911) 155 and Bubák (1916) 61; Lindau (1914) 60 as *Urocystis primulicola* Magn.; Liro (1938) 204 as *Tuburcinia primulicola* (Magn.) Bref. on *Primula farinosa*, *T. Primulae* (Rostr.) Liro on *P. elatior*; Ciferri (1938) 152, as *Ginanniella primulicola* (Magn.) Cif. on *P. farinosa*, *G. Primulae* (Rostr.) Cif. on *P. elatior*.

— **Trientalis** B. & Br. in **19** (2, V, 464, No. 488, 1850) on leaves of *Trientalis europaea* at Aberdeen; **18**, 336; **52**, 212; **15**, 516; **14** (VI, 73) as *Sorosporium Trientalis*; **13**, 254; **40** (VII, N.S., 271, 1884); **10**, 293 as *T. Trientalis*; **9**, 199; **50**, 201; conidial stage **18**, 376, 1860 as *Ascomyces Trientalis*; **15**, 737; **10**, 293 as *Tuburcinia Trientalis*. On *Trientalis europaea*.

Clinton (1904) 446; Schellenberg (1911) 152; Lindau (1914) 54; Bubák (1916) 60; Liro (1938) 201; Ciferri (1938) 154 as *Ginanniella Trientalis* (B. & Br.) Cif.

Urocystis Agropyri (Preuss) Schroet. Cooke **52** (4th ed., 232, 1878) as *U. parallela* on culms and sheaths of rye and on the leaves of Carices (in part); **10**, 286 as *U. Agropyri* on *Triticum* (*Agropyron*) *repens* and *Avena* (*Arrhenatherum*)

elatior; **40** (x, N.S., 4, 277) on *Festuca arenaria*; **9**, 186 in part; **50**, 204 in part. On *Agropyron* and other grasses.

Clinton (1904) 453; Schellenberg (1911) 133; Lindau (1914) 55; Bubák (1916) 62. Liro (1938) 151 as *Tuburcinia Agropyri* (Preuss) Liro on *Triticum repens*, p. 149 as *T. Festucae-elatioris* Hintikka on *Festuca elatior*; Ciferri (1938) 143 as *T. Agropyri* (Preuss) Liro.

Urocystis Anemones (Pers.) Wint. Berkeley exs. No. 236 as *Uredo pompholygodes* on *Anemone nemorosa*; **52**, 212, 1865 as *Polycystis pompholygodes* on *Ranunculus repens* and other members of the Ranunculaceae; **15**, 517 as *Urocystis pompholygodes*; **40** (II, 309) on leaves of *Anemone*, Moray; **14** (V, 100); **13**, 254; **10**, 288 as *U. Anemones* on *R. repens*, *R. bulbosus*, and *A. nemorosa*; **9**, 188; **56** (XXVII, 11 and 14); **56** (XXVII, 937) as *Uromyces* (presumably in error for *Urocystis*) *Anemones*; **71** (XXVIII, B, 137) as *Urocystis Anemones*; **50**, 205; **65** (XXX, 345); **70** (XXI, N.S., 395); **28** (XII, 115) on *Ranunculus Ficaria* and *Trollius europaeus* in Scotland; **22** (No. 79, 93) on *Anemone Pulsatilla*. On Ranunculaceae.

Clinton (1904) 448; Schellenberg (1911) 143; Lindau (1914) 58; Bubák (1916) 66. Liro (1938) 178 and Ciferri (1938) 136 as *Tuburcinia Anemones* (Pers.) Liro on *Anemone nemorosa*. The forms on other genera of the Ranunculaceae are given specific rank.

— **Cepulae** Frost. Cotton **23** (XXVI, 169, 1919) on cultivated onions at Northampton 1917 and 1918; **23** (XXVIII, 443) control; **28** (VII, 65) life history; **24** (IX, 65) control; **96** (II, 106); **23** (XXXIV, 937) on leeks; **65** (XXX, 332 and 338); **23** (XL, 839); **78** (1937, 108) distribution in Britain; **22** (No. 23, 19; No. 33, 45; No. 38, 53 and 55; No. 52, 55 and 56; No. 70, 39; No. 79, 61). On *Allium*.

Clinton (1904) 451; Schellenberg (1911) 140; Bubák (1916) 65; Liro (1938) 167 and Ciferri (1938) 131 as *Tuburcinia Cepulae* (Frost) Liro.

— **Colchici** (Schlecht.) Rab. Berkeley & Broome in **19** (2, V, 464, No. 485, 1850) as *Polycystis Colchici* on leaves of *Colchicum autumnale* at Rudloe, Wiltshire; **18**, 335; **52**, 211; **15**, 517 as *Urocystis Colchici*; **31** (VI, N.S., 421); **81**, 54; **10**, 286; **9**, 186; **56** (XXVII, 399); **50**, 204; **22** (No. 79, 109) on imported bulbs of a species of *Colchicum* and *Bulbocodium vernum*; **22** (No. 117, 56 and 57). On *Colchicum* and *Bulbocodium*.

Clinton (1904) 452; Schellenberg (1911) 137; Lindau (1914) 57; Bubák (1916) 64. Liro (1938) 169 and Ciferri (1938) 141 as *Tuburcinia Colchici* (Schlecht.) Liro.

— **Filipendulae** (Tul.) Schroet. Plowright **28** (I, 60, 1899) as *U. Filipendulae* on *Spiraea Filipendula* on Darnford Down, Salisbury, 1897. On *Spiraea Filipendula*.

Schellenberg (1911) 49; Lindau (1914) 59; Bubák (1916) 69; Liro (1938) 196 as *Tuburcinia Filipendulae* (Tul.) Liro.

— **Fischeri** Koern. Berkeley & Broome **19** (2, V, 464, No. 406, 1850) as *Polycystis parallela* on leaves of *Carex*, Forfarshire; **52**, 212; **15**, 517 as *Urocystis occulta*; **13**, 254 as *Urocystis parallela*; **14** (XIII, 52) as *U. Fischeri* on leaves of *Carex glauca*; **10**, 286; **9**, 186 as *U. Agropyri*; **50**, 204. On *Carex*.

Schellenberg (1911) 135; Bubák (1916); Liro (1938) 159 as *Tuburcinia Fischeri* (Koern.) Liro.

— **Gladioli** (Requien) W.G.Sm. Smith **31** (VI, N.S., 115 and 420, 1876) in corms of *Gladiolus*; **14** (V, 57, 1876); **52** (4th ed., 232); **10**, 287; **9**, 187; **56** (XXVII, 399); **37** (Add. Ser. V, 165, 1906); **50**, 205; **22** (No. 52, 88); **79** (XIII, 34); **22** (No. 117, 121). On *Gladiolus*.

Liro (1938) 173 and Ciferri (1938) 105 as *Tuburcinia Gladioli* (Requien) Liro.

— **occulta** (Wallr.) Rabenh. Berkeley **20**, 375, 1836 as *Uredo parallela* on culms and sheaths of rye, Kensington; **19** (2, V, 464, No. 486, 1850) as *Polycystis parallela*; **18**, 335; **52**, 212; **15**, 517 as *Urocystis occulta*; **81**, 252; **10**, 285; **9**, 185; **50**, 204; **23** (XXV, 1493) control; **22** (No. 38, 22; No. 79, 20). On *Secale*.

Clinton (1904) 452; Schellenberg (1911) 131; Lindau (1914) 55; Bubák (1916) 62. Liro (1938) 155 and Ciferri (1938) 127 as *Tuburcinia occulta* (Wallr.) Liro.

Urocystis sorosporioides Koern. Cooke **14** (VI, 73, 1877) on leaves of *Thalictrum minus*; **52** (4th ed., 232, 1878) on *T. minus* and its var. *maritima*; **40** (IX, N.S., 3, 41); **10**, 287; **9**, 187; **50**, 204. On *Thalictrum*.

Clinton (1904) 450; Schellenberg (1911) 147; Lindau (1914) 58; Bubák (1916) 68; Liro (1938) 191 and Ciferri (1938) 117 as *Tuburcinia sorosporioides* (Koern.) Liro.

— **Violae** (Sow.) Fisch. v. Waldh. *Granularia Violae* Sow. in **42**, t. 440, 1815; **19** (2, v, 464, No. 487, 1850) as *Polycystis Violae* on leaves and especially petioles of violets, Druid's Stoke, Glos. and Isle of Portland, **18**, 335; **31** (XXIV, 464, 1864); **52**, 212; **15**, 517 as *Urocystis Violae*; **31** (VIII, 726); **81**, 54; **13**, 254; **10**, 288 on *Viola odorata* and *V. sylvatica*; **9**, 189; **56** (XXVII, 23); **71** (XXVIII, B, 137); **79** (IX, 43 and XI, 59); **85** (XXXVII, 20 and XXXIX, 19); **22** (No. 70, 60; No. 79, 95). On *Viola*.

Clinton (1904) 450; Schellenberg (1911) 149; Lindau (1914) 59; Bubák (1916) 63. Liro (1938) 197 and Ciferri (1938) 108 as *Tuburcinia Violae* (Sow.) Liro.

GRAPHIOLACEAE

Graphiola Phoenicis (Moug.) Poit. Berkeley & Broome **19** (3, XV, 402, No. 1049, 1865) on leaves of the date palm (*Phoenix dactylifera*), Sheffield Botanic Garden; **15**, 546; **14** (V, 15); **40** (X, N.S. 4, 372) Botanic Gardens, Glasgow; **10**, 298; **9**, 205. On *Palmae*.

Schellenberg (1911) 162 under excluded genera and species; Lindau (1914) 67 under doubtful genera; Bubák (1916) 72; Ciferri (1938) 214.

DOUBTFUL AND EXCLUDED SPECIES

Doassansia Comari (Berk. & White) de Toni & Massee. *Protomyces Comari* Berk. & White in **19** (5, I, 27, No. 1708, 1878) on *Comarum palustre*, Loch of Kinordy, Forfarshire; **14** (VI, 126, 1878); **40** (IV, 255); **13**, 252; as *Doassansia Comari* (Berk. & White) de Toni & Massee in *Journ. Myc.* IV, 18, 1888; **9**, 198; **50**, 201. Transferred to the genus *Physoderma* as *P. Comari* (Berk. & White) Lagerh., see *Bih. k. Svensk. Vet. Akad. Handl.* XXIV, Afd. III, No. 4, p. 11, 1898; **28** (V, 319).

Melanotaenium Ari (Cooke) Lagerh. *Protomyces Ari* Cooke in **14** (I, 7, 1872) on leaves of *Arum maculatum* at Chichester; **52** (4th ed., 227); **10**, 301; R. Beer, **28** (VI, 335) re-examined Cooke's type material and other collections and found the spores to be quite different in character from those of either *Protomyces* or any member of the Ustilaginaceae. It has been accepted as a smut under the name given above by Schellenberg (1911) 109; Bubák (1916) 47 and Ciferri (1938) 161.

Sorosporium scabies Fisch. v. Waldh. **9**, 202, 1891 = *Spongospora subterranea* (Wallr.) Lagerh.

Tilletia Berkeleyi Massee in **37**, 154, 1899 on *Triticum vulgare* from material collected by Berkeley at King's Cliffe, Northants.

Tuburcinia scabies Berk. **52**, 212, 1865; **15**, 516; **10**, 294 = *Spongospora subterranea* (Wallr.) Lagerh.

Ustilago Cucumis A. B. Griffiths. **53** (XV, 404, 1837–88) = name given to zooglea threads in nodules on the roots of *Cucumis sativa*; **31** (XVI, 98, 1894).

Ustilago Ficuum Reichardt **31** (I, 84, 1887) = *Aspergillus Ficuum* (Reichardt) Wehmer = *Sterigmatocystis Ficuum* (Reichardt) P. Henn.

— **grammica** B. & Br. in **19** (2, v, 464, No. 483, 1850) on stems of *Aira aquatica* (probably in error for *Glyceria*) Oxton, Notts; **18**, 335; **52**, 203; **15**, 514; **13**, 252; **10**, 275; **9**, 173. G. R. Bisby and E. W. Mason examined a specimen in the Kew Herbarium from Oxton, Notts (January 1841) and found that the fungus was not a smut but possibly a *Pirostoma*. The host is not an *Aira* but may be *Glyceria aquatica*.

USTILAGINALES RECORDED IN FORAY LISTS

No smut is recorded from the forays of 1897–1904 inclusive. The species listed from subsequent forays are given below, with the dates of the forays, except that for three common species the date of the first foray record is followed by the number of subsequent records. Autumn and spring forays are not distinguished. The names of host plants are omitted, as few of these are noted in the foray reports.

Ustilaginaceae

Cintractia Caricis, 1927, 1938.

Sphacelotheca Hydropiperis, 1905 and eighteen subsequent forays.

Ustilago Avenae, 1918, 1927, 1931, 1938; *Hordei*, 1924; *hypodytes*, 1910, 1912, 1912, 1938; *longissima*, 1909, 1922, 1923, 1927, 1930, 1934, 1937; *nuda*, 1927; *perennans*, 1927 (and as *U. Avenae* in 1914); *Scabiosae*, 1921, 1925, 1926, 1931, 1932, 1936, 1938 (and as *U. flosculorum* in 1916); *striaeformis*, 1927, 1931, 1932, 1934, 1936, 1937, 1938 (and as *Tilletia de Baryana*, in 1921, 1922); *Tragopogi-pratensis*, 1914; *utriculosa*, 1934; *violacea*, 1909 and eighteen subsequent forays (and as *U. Lychnidis-dioicae*, 1928, 1934).

Tilletiaceae

Entyloma Calendulae, 1931, 1932, 1933; *microsporum*, 1924, 1927, 1929, 1930, 1930, 1931, 1933, 1936, 1938; *Ranunculi*, 1926, 1926, 1931, 1932, 1934, 1935, 1936, 1938.

Tilletia decipiens, 1808, 1912, 1938; *Holci*, 1938 (and as *T. Rauwenhoffii*, 1937).

Urocystis Anemones, 1907 and twenty-four subsequent forays; *occulta*, 1911; *Violae*, 1911, 1921, 1924, 1927, 1930, 1936, 1938.

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sylvatica, 305

Zea Mays, 296, 300

A SECOND CONTRIBUTION TOWARDS A KNOWLEDGE OF INDIAN USTILAGINALES

FRAGMENTS XXVI–L

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XXVI. *Ustilago vittata* Berkeley

The smut on an Oplismenoid grass collected at Parasnath, Bihar, was named *Ustilago vittata* by Berkeley (1854) and a second collection on *Oplismenus compositus* Beauv. was referred to the same species by E. J. Butler. Butler stated in an unpublished note that the smut is a species of *Tilletia*, and an examination of the type specimen from Herb. Kew., and of the specimen in the Herbarium Cryptogamae Indiae Orientalis, confirms this view. The host of the type has recently been determined at Kew as *Oplismenus compositus*.

Tilletia vittata (Berk.) Mundkur comb.nov.

Ovaricolous, ovaries much inflated. Spores forming a dusty, black spore-mass covered by a hairy layer of coriaceous host tissue; young spores thick-walled, hyaline, mature spores Kaiser Brown to Liver Brown (Ridgway) or opaque, globose with hyaline or slightly tinted, blunt or somewhat curved scales in the form of a band at the circumference, about 1–2·5 μ wide, seen as small papillae in surface view; diameter 13–21 μ with a mean of 16·5 μ.

On an "Oplismenoid grass" [*Oplismenus compositus*, det. C. E. Hubbard] at Parasnath (4000 ft.), Bihar; collected by Hooker before 1854 (Type).

XXVI. (1) Type.

Diameter (μ)	13	14	15	16	17	18	19	20	
Frequency (n)	1	2	15	40	23	14	4	1	=100

Mean = 16·5 μ.

XXVI. (2) Collected by J. S. Gamble on *O. compositus* Beauv. (No. 21801) in February 1890 at Lawsinghi Ghat, Vizagapatam.

Diameter (μ)	14	15	16	17	18	19	20	21	
Frequency (n)	2	27	77	54	20	13	6	1	=200

Mean = 16·7 μ.

XXVI. (3) Collected at Dehra Dun on *O. compositus* Beauv. in 1928.

Diameter (μ)	14	15	16	17	18	19	20	
Frequency (n)	2	12	43	20	11	11	1	=100

Mean = 16·6 μ.

A smut on *Oplismenus Humboldtianus* Nees (= *O. Burmannii* Beauv.) from Costa Rica was identified as *Ustilago vittata* by Charles (1923). An examination of the specimen, kindly sent by Dr J. A. Stevenson, indicates that that smut is also *Tilletia vittata.*

XXVII. *Tilletia indica* Mitra

Germination of the spores of the smut collected on wheat at Karnal and described as a new species by Mitra (1931), resulted in the formation of unbranched, rather long promycelia, each with a whorl of non-fusing primary conidia (primary sterigmata of Buller), 32–128 or more, at the apex. This smut is therefore a *Neovossia.*

Neovossia indica (Mitra) Mundkur comb.nov.

Ovaricolous, only a few grains in an ear attacked; infected kernels not swollen, partially to completely destroyed; when partially attacked, infection is confined to the grooved side, destroying embryo tissue; in advanced attack, tissues along the groove and the adjacent endosperm are replaced by spores. Spore-mass dark brown to black, dusty, held together by the pericarp. Spores formed singly at the ends of mycelial threads, ellipsoidal, or spherical, a few with appendages; Liver Brown (Ridgway) to opaque; epispore with reticulated proliferations, and projecting into a winged margin at the circumference, 3–6 μ in width; lacunae roundish or irregular; total diameter 24–47 μ with a mean of 33·5 μ; spore proper ranging from 18 to 37 μ with a mean of 27·0 μ. Germination by means of a promycelium with a whorl of 32–128 or more sporidia which do not fuse. The spore mass is fetid.

On *Triticum vulgare* Vill., at Karnal; collected, April 1930, by Abdur Rahman Khan; Type at Herbarium Cryptogamae Indiae Orientalis, New Delhi; co-types at Herb. Kew and the Imperial Mycological Institute, Kew.

XXVII. (1) Type.

Diameter (μ)	24	26	32	37	43	47	
Frequency (n)	16	17	72	89	4	2	=200

Mean = 33·5 μ.

XXVII. (2) Collected at Peshawar in May 1932.

Diameter (μ)	26	32	37	43	49	
Frequency (n)	13	76	82	28	1	=200

Mean = 35·2 μ.

This bunt usually destroys only part of the kernels whereas *T. foetida* (Wallr.) Liro [= *T. foetans* (B. & C.) Trel. = *T. levis* Kühn] and *T. caries* (DC.) Tul. [= *T. Tritici* (Bjrek.) Wint.] destroy the entire grain. *Neovossia indica* differs from these two species and from

Tilletia triticina Ranjovic and *T. controversa* Kühn in spore size and in the mode of germination of the spores. The hosts of the latter two species are *Haynaldia villosa* (L.) Schur. and *Agropyron repens* Beauv., both of which were once placed in the genus *Triticum*.

XXVIII. *Ustilago burmanica* Syd. & Butl.

A smut attacking the inflorescence of a species of *Ischaemum* was named *Ustilago burmanica* by Sydow & Butler (1912). A determination of the host made at the Royal Botanic Gardens, Calcutta, shows that it is *Ischaemum timorense* Kunth. Another collection on *I. spathiflorum* Hook. f. listed under *Ustilago burmanica* by Butler & Bisby (1931) is not this species.

Ustilago burmanica Sydow & Butler

Culmicolous, entire inflorescence destroyed. Sori at first hidden by the leaf sheath and covered by a membrane made up of host cells but later naked, 0·5–3 cm. long. Spores irregularly globose to ellipsoidal, slightly angular, Carob Brown (Ridgway) with thick but smooth cell wall; diameter 10–17 μ with a mean of 13·2 μ.

On *Ischaemum timorense* Kunth at Kya-in, near Moulmein, Burma; collected by E. J. Butler, 9 January 1908 (no. 1424).

XXVIII. (1) Type.

Diameter (μ)	10	11	12	13	14	15	16	17	
Frequency (n)	3	13	44	62	55	13	9	1	=200

Mean = 13·2 μ.

Mycelial strands are present in the sori but they are not of the type characteristic of the genus *Farysia*.

XXIX. Another smut on *Polytoca barbata*

A smut collected by I. H. Burkill in the Sipna valley does not agree with *Ustilago Polytocae* Mundkur (1939) nor with the other species of *Ustilago* on allied grasses and is proposed as the type of a new species.

Ustilago Polytocae-barbatae Mundkur sp.nov.

Soris in ovariis evolutis, intra calycem retentis, atro-castaneis, parum inflatis, columella aliquando praeditis. Sporis pulverulentis, in cumulo nigris, globosis vel sub-globosis, "Amber Brown" (Ridgway), epispora tenui, minute et obscure foveolata, prope marginem laevigata praeditis; 6·3–10 μ diam., in medio 8·6 μ.

Hab. in ovariis *Polytocae barbatae* Stapf, Sipna valley, Amraoti, Indiae or. 11 October 1908, leg. I. H. Burkill (Typus).

Ovaricolous. Sori held together by the sepals; blackish brown and not much inflated; sometimes with a columella. Spores pulverulent,

black in mass, spherical to sub-globose, Amber Brown (Ridgway); spore surface minutely, almost imperceptibly, pitted; epispore thin, edge smooth; diameter 6·3–10·9 μ with a mean of 8·6 μ.

On *Polytoca barbata* Stapf [=*Coix barbata* Roxb. = *Chionachne Koenigii* (Spr.) Thw.]; collected by I. H. Burkill in the Sipna valley, Amraoti District (R.E.P. Field no. 31271), 11 October 1908. Type deposited in Herbarium Cryptogamae Indiae Orientalis, New Delhi, and co-type in the Herbarium of the Imperial Mycological Institute, Kew.

XXIX. (1) Type.

Diameter (μ)	6·3	7	8	9	10	10·6	
Frequency (n)	1	31	30	118	18	2	=200

Mean = 8·6 μ.

This smut differs from *Ustilago Polytocae* in the shape of its smaller spores which have a thinner, minutely pitted epispore, without spines. They differ from those of *U. Coicis* in colour, the absence of echinulations, and the smaller size.

XXX. *Doassansia Nymphaeae* Sydow

Doassansia Nymphaeae was collected at Nirmal and described by Sydow (1912). Co-type material is available both at the Herbarium of the Agricultural College at Poona and the Herbarium Cryptogamae Indiae Orientalis, New Delhi.

Doassansia Nymphaeae Syd.

Petiolicolous, forming large hemispherical tumours, 5–16 mm. long; spore-balls nearly globular to elliptical, 150–235 μ in diameter, enclosed in a tegument; cortical cells slender, yellowish brown, elliptical-oblong, 12·3–17·1 μ long and 6·4–10·5 μ broad; sporidia in whorls of four to six, spindle-shaped, cylindrical.

In the petioles of *Nymphaea stellata* Willd. at Nirmal, near Bassein; collected by H. M. Chibber, 18 February 1912. It has not been reported since from India or elsewhere.

XXXI. The leaf smut of *Alisma plantago* L.

A leaf smut of *Alisma plantago* was determined by Sydow & Butler (1912) as *Doassansia Alismatis*. The specimen agrees with Sydow's Ustilagineen Exsiccaten nos. 186 and 413 but differs slightly in colour and spore size from his Exsiccata nos. 49 and 285.

Doassansia Alismatis (Nees) Cornu

Sori foliicolous, forming yellowish spots which eventually become brownish red; spots subcircular to irregular, 5–12 mm. wide. Spore-balls subcuticular in the palisade or spongy parenchyma, globose or

irregular, flattened against one another, 120–250 μ in diameter. Cortex distinct; cortical cells prominent, radially elongated, 12–26 × 5–14 μ, blunt at both ends, with uniform, dark brown, smooth membranes. Spore-mass completely filling the interior. Spores loosely adpressed, light coloured, ellipsoidal to spherical, some polyhedral, with thick smooth walls; diameter 7–14 μ with a mean of 10·7 μ.

On *Alisma plantago* L. at Achibal (5800 ft.), Kashmir; collected by E. J. Butler (no. 1447), 2 September 1908.

XXXII. The leaf smut of *Potamogeton*

A smut on a species of *Potamogeton* was named *Doassansia Martianoffiana* (Thüm.) Schroet. by Sydow & Butler (1912). This is the only record of this fungus in India and the specimen agrees with Sydow's Ust. Exs. no. 363 and Myc. Germ. no. 2293.

Doassansia Martianoffiana was placed in a subgenus, *Doassansiopsis*, by Setchell (1892), because the central portion of the spore-balls, instead of being filled with fertile spores, is made up of sterile pseudo-parenchymatous cells which are surrounded by a single layer of fertile cells. The subgenus was raised to generic rank by Dietel (1897), but is credited to Setchell by Schellenberg (1912), Ciferri (1938) and Liro (1938).

Doassansiopsis Martianoffiana (Thüm.) Diet.

Foliicolous; sori forming circular, convex spots in the mesophyll; at first yellowish but eventually reddish brown; often merged into indefinite areas covering a large part of the leaves; sometimes also in the petioles. Spore-balls globose to subspherical, 70–250 μ in diameter, consisting of a distinct cortex surrounding a single layer of fertile cells within which is a central mass of pseudo-parenchymatous cells. Cortical cells polygonal, brown, small, 5–8 μ in diameter. Spores ellipsoidal to prismatic, 10–13 μ long, 5–11 μ broad, with pale brown, smooth membrane. Central pseudo-parenchymatous tissue pale yellow and fairly large celled.

On floating leaves of *Potamogeton* sp. in Wular lake, Kashmir; collected by E. J. Butler (no. 1448), 17 September 1908.

XXXIII. *Tolyposporium globuligerum* (B. & Br.) Ricker

This smut on *Leersia hexandra* Swartz, collected in Assam by N. L. Bor, has been compared with the type specimen of *Testicularia Leersiae* Cornu obtained through the courtesy of Dr Roger Heim of the Muséum d'Histoire Naturelle, Paris. According to Cornu (1883) the smut was at first named *Ustilago Leersiae* by Durieu and sent to Tulasne, but the name was never effectively published. Cornu stated that the spore-balls consisted of an external layer of fertile cells with a

central mass of pseudo-parenchymatous cells and named it *Testicularia Leersiae*. Ricker (1905) compared the smut with Berkeley & Broome's (1880) *Thecaphora globuligera* and correctly referred them both to *Tolyposporium* as *T. globuligerum*.

Tolyposporium globuligerum (B. & Br.) Ricker

Ovaricolous; sori subglobose or oblong, 2–3 mm. long, covered by a greenish, smooth membrane, rupturing first at the apex and revealing a black granular spore mass; spore-balls black, opaque, globose to oblong, irregular, firm, 65–210 μ long, 36–108 μ broad, composed of several spores. Spores subglobose, angular, generally polygonal, with dark reddish brown folds of outer coat showing as reticulations, or upon rupture as blunt processes or tubercle-like projections; diameter 6·8–11·5 μ, with a mean of 8·9 μ.

On *Leersia hexandra* Swartz (= *Homalocenchrus hexandrus* O. Kuntze) in Assam; collected by N. L. Bor, 26 November 1936. Also on Dacca Farm, Bengal.

XXXIII. (1) Collected by N. L. Bor in Assam, 1936.

Diameter (μ)	6·8	7	8	9	10	11	11·5	
Frequency (n)	9	19	22	92	45	7	6	=200

Mean = 8·9 μ.

XXXIII. (2) Collected by P. C. Kar, Dacca, Bengal, 1939.

Diameter (μ)	7	8	9	10	10·4	
Frequency (n)	22	37	117	22	2	=200

Mean = 8·7 μ.

Dimensions of the spores of the type specimen, collected by M. Letourneux in August 1862 in Algeria and determined by Cornu, are as follows:

Diameter (μ)	7	8	9	10	11	
Frequency (n)	4	13	51	26	6	=100

Mean = 9·1 μ.

XXXIV. A new species of *Tilletia* on *Panicum*

This smut was collected by K. Bagchee at Calcutta in January 1928 and I (1938) identified it as *Tilletia Ayresii* Berk., but a comparison with the type specimen has shown that it is not that species. The specimen has also been compared with several other species of *Tilletia* reported on species of *Panicum*. It agrees with none of these and is therefore proposed as new.

Tilletia Panici Mundkur sp.nov.

Soris nonnulla ovaria quae dilatantur inficientibus, membrana coriacea, fulva vel atrogrisea, pilis albidis ornata cinctis, ad 18 mm. altis, 6 mm. latis. Sporis subpulverulentis, solitariis, per tempora

diversa maturantibus, cellulis sterilibus hyalinis intermixtis, "Brick Red ad Hessian Brown" [Ridgway] interdum sub-opacis; globosis vel sub-globosis, minute irregulariterque areolatis, prope marginem ergo asperatis; epispora 1·5–2·5 μ lata, cingulo hyalino destituta praeditis; 13·0–19·5 μ diam., in medio 15·8 μ.

Hab. in ovariis *Panici* spec. Calcutta, Indiae or. Leg. K. Bagchee, Ianuarius, 1928 (Typus).

Ovaricolous, only a few ovaries in a panicle attacked; infected ovaries inflated, up to 18 mm. long and 6 mm. broad; covered by a buff to dark grey, coriaceous membrane with silvery white hairs on the outside. Spores semi-dusty, solitary, in various stages of development, intermixed with sterile hyaline cells; Brick Red to Hessian Brown (Ridgway) to almost opaque; spherical to subglobose with minute, irregular, areolate spaces giving the edge a rough appearance; epispore 1·5–2·5 μ thick, without a hyaline band; diameter 13·0–19·5 μ with a mean of 15·8 μ.

On a species of *Panicum* at Calcutta; collected by K. Bagchee, January 1928. Type deposited in Herbarium Cryptogamae Indiae Orientalis, New Delhi and co-type in Herbarium of the Imperial Mycological Institute, Kew (material very scanty).

XXXIV. (1) Type of *Tilletia Panici*.

Diameter (μ)	13·0	14·0	15·6	16·9	18·2	19·5	
Frequency (n)	23	28	51	90	7	1	=200

Mean = 15·8 μ.

This species differs from *T. Ayresii* in possessing larger deeper brown spores, in having irregular areolate spaces and in the absence of minute warts. Wakefield (1920) suggested the merging of *T. Ayresii* into *Ustilago heterospora* and a comparison of the type specimens of the two species confirms this view. The dimensions of the spores are as follows:

Tilletia Ayresii Berk. on *Panicum maximum* Jacq. Type specimen from Herb. Kew.

Diameter (μ)	11	12	13	14	15	16	
Frequency (n)	3	10	28	41	17	1	=100

Mean = 13·6 μ.

Ustilago heterospora P. Henn. (= *Tilletia heterospora* Zundel) on *Panicum maximum* Jacq. Type specimen from Mus. Bot. Berol.

Diameter (μ)	11	12	13	14	15	16	
Frequency (n)	3	11	20	45	20	1	=100

Mean = 13·7 μ.

Tilletia Panici has been compared with the type specimens of *T. courtetiana* Har. & Pat. and *T. verrucosa* Cooke & Massee and with the authentic specimens of *T. pulcherrima* Ell. & Gall. and *T. Maclagani* (Berk.) Clinton.

T. courtetiana has perfectly spherical, brownish black spores with a reticulate epispore, subpentangular alveoli, 4 μ in diameter, and the following dimensions of spores.

T. courtetiana Pat. & Har. on *Panicum proliferum* Lam. Type specimen.

Diameter (μ)	18·6	20·5	22·3	24·2	
Frequency (n)	3	42	50	5	= 100

Mean = 21·5 μ.

Tilletia verrucosa has globose to subglobose spores of yellowish brown colour, bristling with acute, pyramidal warts about 3 μ high and the following dimensions of spores.

Tilletia verrucosa Cooke & Massee on *Panicum coloratum* Nees (= *P. Swynnertonii* Rendle). Type.

Diameter (μ)	16·8	18	19·3	20·5	21·8	23·1	24·4	
Frequency (n)	4	9	22	52	9	3	1	= 100

Mean = 20·1 μ.

Tilletia pulcherrima has opaque, spherical to subspherical spores with a more or less evident hyaline membrane bearing truncate, scale-like projections 2 μ thick and the following dimensions of spores.

Tilletia pulcherrima Ell. & Gall. on *Panicum capillare* L. (Seymour and Earle, Econ. Fungi, C. 52).

Diameter (μ)	18·6	22·3	26·0	29·8	
Frequency (n)	7	24	59	10	= 100

Mean = 25·0 μ.

Tilletia Maclagani attacks both the ovaries and the anthers; its spores are light to dark reddish brown, more elongate and somewhat irregular in size, the epispore is 3–4 μ thick bearing minutely areolate pits, and spores have the following dimensions:

Tilletia Maclagani (Berk.) Clinton on *Panicum virgatum* Roxb. (Seymour and Earle, Econ. Fungi, Suppl. C. 126).

Diameter (μ)	16·8	18·0	19·3	20·6	21·8	23·1	24·4	
Frequency (n)	2	16	24	50	5	2	1	= 100

Mean = 19·9 μ.

Tilletia Panici differs from all these four species, none of which has so far been recorded from India.

XXXV. *Ustilago endotricha* Berk.

Ustilago endotricha was described by Berkeley (1854) on *Gahnia* sp. collected at Auckland, New Zealand, by Dr R. H. Sinclair. The smut collected in India on *Carex condensata* Nees by Hooker was also placed in this species by Berkeley with the remark that the spores of the Indian specimen were much smaller than those of the collections from Ceylon and New Zealand. An examination of the type and the two Indian collections, kindly made available by the Director, Royal

Botanic Gardens, Kew, shows that the latter are not *Ustilago endotricha*. Cunningham (1926) records that in the folder of *U. endotricha* (labelled "*U. trichophora*") at Kew, only the type collection consisting of a single specimen really belongs to this species. The Ceylon specimens, for example, were found by Petch (1912) to be *U. olivacea* (DC.) Tul.

U. endotricha was transferred by Sydow (1919) to Raciborski's genus *Farysia*. Its description by Petch (1912) on which Cunningham (1924) based that of *Elateromyces endotrichus* G. H. Cunn. is inaccurate, the spores especially being incorrectly described. Cunningham (1926) gave an emended description drawn up from the type specimen in a subsequent publication, to which may be added the following dimensions of the spores:

Farysia endotricha (Berk.) Syd. Type.

Diameter (μ)	7	8	9	10	11	12	13	14	15	
Frequency (n)	1	1	9	18	20	24	11	13	3	= 100

Mean = 11·6 μ.

The Indian collections on *Carex condensata* were compared with the exsiccatae of *Farysia olivacea* (= *Ustilago olivacea*) in Sydow's Ustilagineen. There are three specimens (no. 14, 357, and 383), but it was difficult to decide which was that of *Farysia olivacea* as they differed very considerably among themselves. Both Ciferri (1931, 1938) and Liro (1938) are agreed, however, that Sydow's no. 357 is that of *F. olivacea*, and the illustration of the spores in McAlpine (1910) is also from this specimen. The Indian specimens do not, however, agree with it but do so with the description of *Farysia Pseudocyperi* (de Toni) Zundel (1931) which Ciferri (1933) did not include in his key to the species of the genus *Farysia*.

Farysia Pseudocyperi (de Toni) Zundel

Ovaricolous, ovaries completely destroyed and converted into an olive brown dusty mass of shreds and spores. Spores borne between sterile, brownish elaters or shreds, globose, ellipsoidal, occasionally long and irregular, Saccardo's Olive (Ridgway) with a thick, distinct, very minutely verruculose epispore; diameter 6·0–10·3 μ with a mean of 7·7 μ.

On *Carex condensata* Nees (not "*baccans*"); collected by Hooker in East Nepal (Tambur River) before 1854 and on Khasi Hills by Hooker and Thompson.

XXXV. (1) East Nepal specimen.

Diameter (μ)	6	7	8	9	10	10·3	
Frequency (n)	10	34	35	18	2	1	= 100

Mean = 7·7 μ.

XXXV. (2) Khasi Hills specimen.

Diameter (μ)	6	7	8	9	9·6	
Frequency (n)	7	33	48	11	1	=100

Mean=7·7 μ.

This smut does not differ very much from *Farysia Butleri* Syd. except that the latter has slightly more prominent verruculations and irregularly shaped spores. Zundel (1931) cites Saccardo as the authority for the epithet *Pseudocyperi*, but it was proposed by de Toni who compiled Volume VII$_2$ of *Sylloge Fungorum*.

XXXVI. *Farysia Butleri* Syd.

Farysia Butleri was originally described in the genus *Ustilago* by Sydow in Sydow & Butler (1906) but was later transferred by him (1919) to the genus *Farysia*. In addition to the co-type specimen, two others collected in Assam were available in the Herbarium Cryptogamae Indiae Orientalis, New Delhi.

Farysia Butleri (Syd.) Syd.

Ovaricolous, ovaries completely destroyed and converted into a deeply olive-brown mass of shreds and spores. Spores borne between deep brown sterile elaters, subglobose, broadly ellipsoidal or irregular, Saccardo's Olive (Ridgway); epispore with dense and prominent tubercles; diameter of spores 6·4–11·0 μ with a mean of 8·1 μ.

On *Scleria elata* Thw. at Thurya, Assam, collected by E. J. Butler, 16 May 1905; on *Scleria* sp. at Cherrapunji, collected by L. S. S. Money, 29 October 1914; on *Scleria* sp. at Syndai, Assam.

XXXVI. (1) *Farysia Butleri* Syd.

Diameter (μ)	6·4	7	8	9	10	11	.
Frequency (n)	6	44	82	55	10	3	=200

Mean=8·1 μ.

The two other collections have identical range and mean.

XXXVII. *Ustilago consimilis* Sydow

A culmicolous smut on a host identified as *Saccharum fuscum* Roxb. was referred to the species *Ustilago Sacchari* Rabenh. by Sydow & Butler (1912) who, however, remarked that it did not fully agree with the form on *Saccharum officinarum* L. Sydow (1924) later erected the species *Ustilago consimilis* to accommodate this smut. An emended description has been recently given by me (1939*b*). *Saccharum fuscum* was placed by A. Camus in the genus *Sclerostachya*.

Ustilago consimilis Sydow

Culmicolous, completely destroying the inflorescence and part of the axis; sorus covered by the leaf-sheath, not extending into a long flagelliform structure; columella present and vestiges of a membrane made up of host tissue. Spores black in mass, dusty, spherical to slightly oval, Chestnut (Ridgway) with thick epispore, margin and spore surface smooth; diameter 3·7–6·2 μ with a mean of 5·0 μ.

On *Sclerostachya fusca* (Roxb.) A. Camus (see below), Sibsagar, Assam; collected by B. C. Basu, 18 December 1910. A second collection was made by T. N. Sen, January 1938, on (?) "*Erianthus Ravennae*" Beauv.

XXXVII. (1) *Ustilago consimilis* Syd. Co-type.

Diameter (μ)	3·7	4	5	6·2	
Frequency (n)	7	13	150	30	=200

Mean = 5·0 μ.

XXXVII. (2) Collected by T. N. Sen in January 1938 on "*Erianthus Ravennae* Beauv." (see below).

Diameter (μ)	3·5	4	5	6·3	
Frequency (n)	9	26	119	46	=200

Mean = 5·1 μ.

When he sent the original specimen, B. C. Basu stated that the host was called "Ikra" grass and the name *Saccharum fuscum* was supplied at the time by the Royal Botanic Gardens, Calcutta. Dr N. L. Bor, an authority on Assam grasses, states, however, that the name "Ikra" is applied to a robust variety of *S. spontaneum* L. The host of the second specimen was identified as *Erianthus Ravennae* Beauv. but this grass does not occur in Assam, according to Bor. Possibly this host is also *Saccharum spontaneum* L.

XXXVIII. *Ustilago scitaminea* Syd.

As a result of a critical examination of the culmicolous smuts attacking *Saccharum officinarum* L. and *S. Barberi* Jesw., I (1939*b*) concluded that they really formed one species and two varieties. The diagnosis of *Ustilago scitaminea* given by Sydow has been somewhat emended.

Ustilago scitaminea Syd.

Culmicolous, greatly altering the floral axis; sorus extending into a long, curved, flagelliform structure, at first covered by a delicate membrane of host tissue, later naked; lower part hidden by the leaf-sheath; columella present. Spores powdery, black in mass, spherical to subglobose, Rood's Brown to Prout's Brown (Ridgway) with thin

epispore and smooth margin; spore surface very minutely punctate; diameter 5·5–9·7 μ with a mean of 7·3 μ.

On *Saccharum officinarum* L. and *S. Barberi* Jesw. in India, Java, Burma and South Africa.

XXXVIII. (1) Collected on sugarcane on Manjri Farm, Poona, by E. J. Butler on 25 October 1905.

Diameter (μ)	5·7	6	7	8	9·1	
Frequency (n)	3	18	117	45	17	=200

Mean=7·3 μ.

Ustilago scitaminea Syd. var. ***Sacchari-Barberi*** Mundkur

The diagnosis is as for *Ustilago scitaminea* except that the spores are Mummy Brown (Ridgway) with a thicker epispore, slightly rough margin and very minutely verrucose spore surface; diameter 5·1–8·0 μ with a mean of 6·6 μ.

On *Sacchari Barberi* Jesw. and *S. officinarum* L. at Partabgarh, Amritsar, Karnal, Lyallpur and Sepaya. On *S. spontaneum* L. at Pusa and Hoshangabad.

XXXVIII. (2) Collected on sugarcane by Hafiz Khan at Amritsar, 13 October 1907.

Diameter (μ)	5·1	6	7	8	
Frequency (n)	1	82	108	9	=200

Mean=6·6 μ.

Ustilago scitaminea Syd. var. ***Sacchari-officinarum*** Mundkur

The diagnosis is as for *Ustilago scitaminea* except that the spores are Vandyke Brown (Ridgway) with a medium thick, coarsely echinulate epispore, and a diameter of 6·5–11·3 μ, with a mean of 8·3 μ.

On *Saccharum officinarum* L. in Sambalpur; collected on 9 June 1904.

XXXIX. A smut on *Neyraudia arundinacea* (L.) Henry

This smut was sent to me by N. L. Bor from the Botanical Gardens, Dehra Dun. It does not agree with any smut reported on the section *Poaceae* of the tribe *Eragrostis* and is proposed as a new species.

Ustilago Neyraudiae Mundkur sp.nov.

Soris ovaria inflata, e glumis nonnullarum spicularum dealbatarum manifeste protrudentia inficientibus; membrana viridi coriacea cinctis; columella carentibus; massam sporarum primo aliquanto agglutinatam, dein pulverulentam includentibus. Sporis ellipticis, globosis vel irregularibus, epispora crassa, laevi vel obscure granulata praeditis; "Carob Brown" [Ridgway]; 6·7–11·9 μ diam., in medio 9·2 μ.

Hab. in ovariis *Neyraudiae arundinaceae* (L.) Henry, Dehra Dun, Indiae or. 6 October 1938, leg. N. L. Bor.

Ovaricolous, affected spikelets whitish, only a few spikelets in a panicle attacked. Ovaries inflated, protruding prominently out of the glumes. Sori covered by a greenish coriaceous membrane of host tissue; no columella. Spore-mass black, slightly agglutinated but later dusty. Spores ellipsoidal to globose or sometimes irregular, epispore thick, smooth or with very obscure granulations on surface, Carob Brown (Ridgway); diameter 6·7–11·9 μ with a mean of 9·2 μ.

On *Neyraudia arundinacea* (L.) Henry (= *N. madagascariensis* Hook. f.) at Dehra Dun; collected by N. L. Bor on 6 October 1938. Type deposited in the Herbarium Cryptogamae Indiae Orientalis, New Delhi, co-types in Herbarium of the Imperial Mycological Institute, Kew and Herb. Kew.

XXXIX. (1) Type.

Diameter (μ)	6·7	8	9	10	11	11·9	
Frequency (n)	6	29	94	51	17	3	=200

Mean = 9·2 μ.

XL. *Tolyposporium Penicillariae* Brefeld

This species was described by Brefeld (1895) on *Penicillaria spicata* Willd. (= *Pennisetum typhoides*) sent to him by A. Barclay. A fragment of the type specimen was kindly sent by Dr E. Ulbrich, of the Berlin Botanical Museum, where Brefeld's Herbarium is deposited. The label on the type specimen states "Von Barclay erhalten aus Indien, II 1891".

Collections of this smut have since been made on *P. typhoides* (Bajra) at Coimbatore, Nadiad, Pusa, Sialkot and elsewhere.

Tolyposporium Penicillariae Bref.

Ovaricolous, only few ovaries in an ear attacked; smutted ovaries enlarged into oval or pear-shaped bodies 3–4 mm. long and 2–3 mm. broad, bluntly rounded or conical at the apex; sori chocolate-brown, covered by a tough membrane composed of host tissue, crumbling into coarse black powder, formed mostly of roundish spore-balls. Spore-balls of unequal size, from 40–140 μ in diameter, consisting of several spores tightly pressed together and breaking apart with difficulty. Spores oval, ellipsoidal, some spherical, Antimony Yellow to Yellow Ochre (Ridgway) with a thin spore wall and smooth surface; diameter 6·5–12·3 μ with a mean of 9·3 μ; spore contents granular.

On *Pennisetum typhoides* Stapf & Hubbard (Bajra); collected by A. Barclay in India about 1891. Also at Pusa, Coimbatore, Nadiad,

Ahmedabad and Sialkot; known to occur in Sind, United Provinces and the Punjab.

XL. (1) Type from Mus. Bot. Berol., collected by A. Barclay in India.

Diameter (μ)	6·5	7	8	9	10	11	12·3	
Frequency (n)	1	4	21	104	48	14	8	=200

Mean = 9·3 μ.

The remark by Butler & Bisby (1931) that the Bajra smut occurring in the plains does not agree with Brefeld's description, is true only of the smut on this millet from Poona, which is dealt with separately (No. XLI).

Tolyposporium Penicillariae was recorded by Yen (1938) from Africa, where it was collected on *Pennisetum typhoides* (?) at Ouadai, Tehad. The spore-balls are stated to be blacker and slightly larger than those of a German specimen at Paris but spore characters are reported as identical. These were not described nor were comparative measurements given, and it is not certain that the German specimen referred to was the type. As another species of *Tolyposporium* occurs on bulrush millet (*Pennisetum leonis* Stapf & Hubbard) in Africa, in a locality not far from Tehad, a re-determination of Yen's specimen seems desirable. Yen germinated the spores without any difficulty, which does not agree with the experience of Brefeld (1895) and Butler (1918).

XLI. *Tolyposporium senegalense* Speg.

The smut collected at Poona on Bajra (*Pennisetum typhoides*) was referred to the species *Tolyposporium Penicillariae* Bref. by Sydow and Butler (1907) with the remark that it did not agree with the diagnosis of that species given by Brefeld (1895). A comparison with the type specimen of *T. Penicillariae* reveals that there are considerable differences between the two smuts. The Poona specimen agrees in general with *T. senegalense* except that the latter is reported to have slightly larger spore-balls; the spore size, 8–10 × 6–10 μ, is within the range obtained by me. A comparison with the type or other authentic specimen has not been possible.

Tolyposporium senegalense Spegazzini

Ovaricolous, only a few ovaries in an ear attacked; infected ovaries inflated, ellipsoidal, truncated at apex, black. Sori covered by a rigid, brownish black membrane made up of host tissue; no columella; finally crumbling into numerous spore-balls. Spore-balls black, nearly smooth, not easily breakable, ellipsoid-ovoid or irregular, 37–126 × 34–92 μ. Spores globose, ellipsoidal, angled, some irregular, Vandyke Brown to Liver Brown (Ridgway) with rather thick, faintly

areolate epispore, smooth surface and margin, some with folds; diameter 5·7–9·7 μ with a mean of 7·6 μ.

On *Pennisetum typhoides* Stapf & Hubbard at Poona; collected by the Farm Superintendent in 1906 and received at Pusa on 5 February 1907.

XLI. (1) Butler's no. 886, collected at Poona in 1906.

Diameter (μ)	5·7	6	7	8	9	9·7	
Frequency (*n*)	2	15	93	45	43	2	=200

Mean = 7·6 μ.

Two collections of a smut on the African bulrush millet (*Pennisetum leonis* Stapf & Hubbard), collected by F. C. Deighton in Sierra Leone, have also been critically examined. They agree in all major respects with *Tolyposporium senegalense* excepting that the spore-balls are 25–85 × 24–61 μ and less firm, while the spores are faintly lighter. These two collections come from very close to the type locality of *Tolyposporium senegalense* and belong to that species.

T. senegalense, collected on *Pennisetum leonis* by F. C. Deighton at Kambia, Sierra Leone on 28 December 1927. No. M 175.

Diameter (μ)	6·3	7	8	9	10	11	
Frequency (*n*)	2	47	90	32	25	4	=200

Mean = 8·2 μ.

A specimen from Njala, Sierra Leone, was referred by Ciferri (1931, p. 57) to *Ustilago Penniseti* Rabenh. The host was *Pennisetum leonis* (a species not described until 1933), but was sent as *P. ?typhoideum*. It is evident that this smut is not the same as the type of *Ustilago Penniseti* Rabenhorst (1871), here redescribed from the specimen in Herbarium G. Winter, kindly sent by Dr E. Ulbrich.

Ustilago Penniseti Rabenhorst

Ovaricolous, smutted ovaries slightly swollen; sori black, covered by a membrane of host tissue; a columella may be present, but it is not distinct. Spores pulverulent, solitary; black in mass, globose to ellipsoidal, Liver Brown (Ridgway), very faintly echinulate with a thick epispore; diameter 8·9–13·8 μ with a mean of 11·2 μ.

On *Pennisetum fasciculatum* Trin. at Marasch, Iran; collected by C. Haussknecht, 15 July 1865. Dimensions of the spores of the type are as follows:

Diameter (μ)	8·9	10	11	12	13	13·8	
Frequency (*n*)	3	28	32	37	8	2	=110

Mean = 11·2 μ.

De Toni (1888) cited *Uredo* (*Ustilago*) *trichophora* var. *Penniseti* Kunze as a synonym of Rabenhorst's smut, gave a larger host range, included Egypt and Madeira Isles as localities and gave the spore

diameter as 5·5–12 μ; the type locality is not even mentioned. De Toni is thus responsible for some of the confusion in the identification of smuts on *Pennisetum*.

XLII. A new smut on *Coix Lachryma-Jobi* L.

Smutted racemes of *Coix Lachryma-Jobi* collected by S. L. Ajrekar are labelled *Ustilago Coicis* Brefeld in the Herbarium Cryptogamae Indiae Orientalis, but the specimen does not agree with *Ustilago Coicis* or with the smuts reported on related genera and is therefore proposed as a new species.

Ustilago Lachrymae-Jobi Mundkur sp.nov.

Soris ovaria nonnulla inficientibus, eaque omnino destruentibus, magnis, funebre castaneis, glumis cinctis; columella carentibus. Sporis levibus, "Diamine Brown" [Ridgway], irregulariter globosis vel ellipticis, angulatis, epispora tenui praeditis; 7–15 μ diam., in medio 11·4 μ.

Hab. in ovariis *Coicis Lachrymae-Jobi* L. Girnar, Junagadh, Indiae or. 19 September 1913, leg. S. L. Ajrekar (Typus).

Ovaricolous, not all ovaries in a raceme affected; smutted ovaries entirely destroyed, male flowers not attacked. Sori large, deep brown, covered by the glumes and without columella. Spores smooth, Diamine Brown (Ridgway), irregularly globose to ellipsoidal or angled, with thin cell-wall, giving the spores a crumpled appearance; diameter 7–15 μ with a mean of 11·4 μ.

On *Coix Lachryma-Jobi* L. on Girnar Hills, Junagadh; collected by S. L. Ajrekar, 19 September 1913. Type specimen deposited in the Herbarium Cryptogamae Indiae Orientalis and co-type in the Herbarium, Imperial Mycological Institute, Kew.

XLII. (1) Type.

Diameter (μ)	7	8	9	10	11	12	13	14	15	
Frequency (n)	1	4	23	23	52	55	21	16	5	=200

Mean = 11·4 μ.

The spores of this smut differ from those of *Ustilago Coicis* in possessing a smooth and thin epispore, in their irregular shape and larger size.

Since *U. Coicis* was reported by me (1939*a*) a specimen of *Coix Lachryma-Jobi* collected at Shillong by H. Collet on 3 October 1890 became available for examination through the kindness of Dr K. Biswas, Superintendent, Royal Botanic Gardens, Calcutta. Some of the ovaries of the specimen were attacked by *Ustilago Coicis*. The measurements are given below.

XLII. (2) Collected by H. Collet at Shillong.

Diameter (μ)	7	8	9	10	11	12	
Frequency (n)	7	12	117	53	9	2	=200

Mean=9·2 μ.

U. Coicis has been reported on the same host by Raciborski (1900) from Java. His description agrees with that of the type specimen but material was not available at Buitenzorg and none could be obtained from his herbarium at Cracow, Poland.

U. Coicis was found by Thomas (1920) on *Coix Lachryma-Jobi* in the quarantine-house at Washington, D.C., on plants from seed received from the Philippines where, presumably, the smut also occurs. A fragment of this smut accompanied by *Ustilago Coicis* on *Coix agrestis* collected by S. Kusano, 16 September 1904, in Japan and distributed in Vestergren, *Micromycetes rariores selecti* (no. 1141) was kindly sent by Dr J. A. Stevenson of the U.S. Department of Agriculture. The fungi have been compared with the type specimen with which they agree in all respects.

A smut on *Coix agrestis* Lour. has been identified as *Ustilago Coicis* and reported by Tai (1937) from China. Examination of a specimen sent by him indicates that it is an undescribed species of *Tilletia*.

Tilletia Taiana Mundkur sp.nov.

Soris inflorescentiam totam destruentibus, in vagina pro parte occlusis, massam sporarum atrocastaneam ad nigram includentibus. Sporis globosis vel ellipticis, epispora areolas polygonales vel elongatas, lineolis 2·3 μ crassis, 1·5 μ altis limitatas exhibenti praeditis; "Brownish-Olive" [Ridgway]; 10·0–16·0 μ diam., in medio 13·2 μ.

Hab. in inflorescentiis *Coicis agrestis* Lour.; Yunan, Sina 20 November 1938, leg. T. H. Wang (Typus).

Entire inflorescence destroyed; sori partly concealed by the sheath; spore-mass dark brown to black, pulverulent. Spores globose to oval, rarely ellipsoidal, with polygonal or rarely elongate reticulations (2·3 μ wide and 1·5 μ deep), showing as projections at the circumference; enveloping membrane absent; Brownish Olive (Ridgway); diameter 10·4–16·3 μ with a mean of 13·2 μ. Chains of sterile cells with thick walls and light brown colour present. Germination by means of a slender promycelium resulting in an apical whorl of twenty to twenty-two primary conidia; fusion not observed.

On *Coix agrestis* Lour. at Yunan, China; collected by T. H. Wang on 20 November 1938. Type deposited in the Herbarium Cryptogamae Indiae Orientalis, New Delhi, and co-type in Herbarium, Imperial Mycological Institute, Kew.

Type. *Tilletia Taiana* on *Coix agrestis* Lour.

Diameter (μ)	10	11	12	13	14	15	16	
Frequency (n)	5	11	39	76	37	22	10	=200

Mean = 13·2 μ.

Ciferri (1934) limits the genus *Tilletia* to the ovaricolous smuts but *Tilletia Taiana* destroys the entire inflorescence. Its spore characters and germination leave no doubt regarding its position in that genus and the limitation which Ciferri proposes is not therefore justified.

XLIII. *Ustilago Hordei* (Pers.) Lagerheim

Ustilago Hordei occurs wherever barley is grown in India. There are several collections in the Herbarium Cryptogamae Indiae Orientalis all of which have been compared with exsiccatae (Sydow's Ustilagineen, no. 207, Briosi and Cavara's Funghi Parassiti, no. 401 and no. 62, 63, 64 and 65 of the Mycological Exchange of the U.S. Department of Agriculture), with which they agree.

Ustilago Hordei (Pers.) Lagerh.

Sori in spikelets forming a black-brown, compact spore-mass covered, usually permanently, by the transparent basal parts of the glumes. Spores adhering, globose to ellipsoid, often somewhat angular by pressure, Carob Brown (Ridgway) but slightly lighter coloured on one side indicating a thinner wall, smooth; diameter 5·5–8·7 μ with a mean of 6·8 μ (elongate spores, 9–11 μ, reported, but not seen in Indian specimens).

On cultivated barley (*Hordeum*) throughout India.

XLIII. (1) *Ustilago Hordei* on cultivated barley.

Diameter (μ)	5·5	6	7	8	8·7	
Frequency (n)	6	49	124	18	2	=199

Mean = 6·8 μ.

Two other smuts have also been reported on barley by Tapke (1932) and Ruttle (1934), *Ustilago nigra* Tapke and *U. medians* Biedenkopf. These have been separated from *U. Hordei* and *U. nuda* by the colour of the spore-mass, spore characters, mode of germination and of infecting the host. None of the Indian collections of *U. Hordei* agree with the exsiccata of these species, kindly supplied by Dr V. F. Tapke and Mrs M. L. Ruttle.

XLIV. *Tilletia tumefaciens* Syd.

This remarkable smut which causes enormous galls on the host was named *Tilletia tumefaciens* by Sydow in Sydow & Butler (1912). The entire growing portion including the young leaves, stem and panicle are converted into a large hood-shaped gall. The type specimen,

which is very scanty, was deposited by Sydow in the Herbarium Cryptogamae Indiae Orientalis.

Tilletia tumefaciens Syd.

Sori developing in the apical region converting the stem, bud-leaves and panicle into large hood-shaped galls, up to 8 cm. long and 2 cm. broad and filled with rust-coloured, powdery spores. Spores globose, in various stages of development, immature ones Ferruginous (Ridgway) and mature ones Kaiser Brown (Ridgway); diameter 17–23 μ with a mean of 20·6 μ; epispore 3–4 μ thick, covered with a network of raised, five- to six-angled reticulations, 2·5 μ high and 4–7 μ broad, with a smooth hyaline membrane covering the spores.

On *Panicum antidotale* Retz., at Lyallpur; collected by D. Milne, 30 September 1909 (Type).

XLIV. (1) Type.

Diameter (μ)	17	19	21	23	
Frequency (n)	2	15	23	10	=50

Mean = 20·6 μ.

XLV. *Ustilago Ahmadiana* Syd.

Ustilago Ahmadiana Sydow was the name given by Sydow (1938) to a smut on *Polygonum rumicifolium* collected by Mr S. Ahmad. A part of the co-type (no. 3*a*) became available for examination through the courtesy of the collector.

Ustilago Ahmadiana Syd.

Ovaricolous, almost entirely destroying the ovaries but spores held together by a tough membrane made up of host tissue. Spore-masses flesh coloured or pale reddish brown and powdery. Spores spherical to subspherical, some ellipsoidal or elongate; Pale Vinaceous-Lilac to Pale-Lilac (Ridgway); spore membrane thin with five- to six-angled compartments on the surface caused by reticulations; each compartment 1·5–2·0 μ; reticulations subhyaline to slightly pinkish, 1 μ in height; diameter 7·8–11·3 μ with a mean of 8·9 μ.

On *Polygonum rumicifolium* Royle in Rotang Pass, Kulu; collected in 1936 by S. Ahmad.

XLV. (1) *Ustilago Ahmadiana*. Co-type (no. 3*a*).

Diameter (μ)	7·8	8	9	10	11·3	
Frequency (n)	10	23	97	5	5	=140

Mean = 8·9 μ.

Sydow (1938) remarks that the smut is closely related to *Ustilago carnea* Liro and *U. anomala* J. Kunze. A comparison with these species distributed by Sydow [Ustilagineen no. 1 and 376—the former is

U. carnea according to Liro (1924)] shows that *U. Ahmadiana* differs from both in size and colour of spores.

XLVI. Leaf smut on *Papaver Rhoeas* L.

A smut on *Papaver Rhoeas* collected at Lahore on 11 July 1939 by B. B. L. Dutta and G. Singh was sent to the Herbarium Cryptogamae Indiae Orientalis for identification. It agrees very well with the exsiccata of the leaf-smut on this host distributed by Sydow (Ustilagineen no. 86 and 320) under the name *Entyloma bicolor* Zopf. The name *E. bicolor* is, however, a synonym of *E. fuscum* Schroet.

Entyloma fuscum Schroet.

Sori in leaves forming irregular, whitish, yellowish, grey spots, later brown and dried up. Spores more or less irregularly globose to ellipsoidal, Sudan Brown to Brussels Brown (Ridgway); endospore uniformly developed, thin, hyaline to rusty coloured or weakly yellow; exospore uniformly thick, indistinctly two or three layered, the external layer yellow-brown, the inner bright yellow, both together usually 2–3 μ, in places up to 5–6 μ thick; diameter 11·2–18·6 μ with a mean of 14·6 μ.

On *Papaver Rhoeas* L. at Lahore; collected by B. B. L. Dutta and G. Singh on 11 July 1939.

XLVI. (1) *Entyloma fuscum* Schroet. Lahore.

Diameter (μ)	11·2	13	15	17	18·6	
Frequency (n)	13	43	118	19	7	=200

Mean = 14·6 μ.

XLVII. A new smut on *Euphorbia dracunculoides* Lamk.

Mr Sultan Ahmad sent me for determination some smutted seeds of *Euphorbia dracunculoides*, collected by him at the Rice Experiment Station, Kalashakaku, Punjab. The smut is a new species of *Ustilago*, for which the name *U. Euphorbiae* is proposed. No smut has previously been described on any species of the family Euphorbiaceae, nor indeed of the order Euphorbiales.

Ustilago Euphorbiae Mundkur sp.nov.

Soris fructices inficientibus seminaque destruentibus. Massa sporarum castanea vel nigra, in pericarpio sine columella inclusa, dein pulverulenta. Sporis globosis, ellipticis vel aliquando irregularibus, epispora tenui, laevi praeditis; "Vinaceous-Buff" ad "Vinaceous-Fawn" [Ridgway], 3·7–9·3 μ diam., in medio 5·8 μ.

Hab. in fructices *Euphorbiae dracunculoidis* Lamk., Kalashakaku, Punjab, Indiae or.; legit Sultan Ahmad, 18 August 1936.

Fructicolous, endosperm, cotyledons and embryo entirely destroyed, testa intact. Spore-mass deep chocolate-brown to black, firmly held together by the pericarp, later dusty, without columella. Spores spherical, oval or irregularly ellipsoidal; epispore thin, smooth, slightly darker brown; colour "Vinaceous-Buff to Vinaceous-Fawn" [Ridgway]; diameter 3·7–9·3 μ with a mean of 5·8 μ.

On *Euphorbia dracunculoides* Lamk. at Kalashakaku, Punjab; collected by S. Ahmad on 18 August 1936. Type deposited in the Herbarium Cryptogamae Indiae Orientalis, New Delhi, co-types in Kew Herbarium, and Herbarium, Imperial Mycological Institute, Kew.

XLVII. (1) Type.

Diameter (μ)	3·7	4	5	6	7	8	9	9·3	
Frequency (n)	3	6	66	82	30	9	3	1	=200

Mean = 5·8 μ.

Attempts to germinate the spores proved unsuccessful.

XLVIII. *Entyloma Dahliae* Syd.

Leaves of *Dahlia coccinea* Desf. (horticultural variety) affected by yellowish to medium brown and withered looking spots, collected on 10 January 1936 in the Victoria Gardens, Bombay, were found to be attacked by a species of *Entyloma*. Two species of this genus are known to attack species of *Dahlia*, viz. *Entyloma Dahliae* Syd. (1912) and *E. Unamunoi* Ciferri (1925). Type or authentic specimen of the latter was not available but an authentic specimen of *E. Dahliae* was kindly sent by Dr I. B. Pole-Evans (who had originally collected the type specimen in Natal) with which the Indian specimens agree very well.

Entyloma Dahliae Syd.

Foliicolous, forming amphigenous spots 1–10 mm. wide at first dirty white, later yellowish brown, orbicular to elliptical, definite and conspicuous. Spores irregularly globose smooth, Yellow Ochre to Buckthorn Brown (Ridgway); diameter 9·3–15·6 μ with a mean of 12·7 μ, epispore 1·5–2·5 μ thick. Conidia not seen.

On *Dahlia coccinea* Desf. in the Victoria Gardens, Bombay; collected by B. B. Mundkur, 10 January 1936. On *Dahlia* sp. at Mussoorie; collected by G. Watts Padwick, 24 September 1939.

XLIX. A smut on *Dactyloctenium scindicum* Boiss.

A smut on *Dactyloctenium scindicum* (=*Eleusine aristata* Ehrenb.) was collected in the Punjab plains by Mr Sultan Ahmad. It agrees with *Ustilago Eleusines* Syd. (nec Kulkarni), recorded by him (1922) from China on *Eleusine indica*. It has not been possible to compare the specimen with the type but Sydow's description is sufficiently precise

to enable the determination of the Indian specimen as that species. As the specific epithet "*Eleusines*" (an orthographic variant of "*Eleusinis*") had been used by Kulkarni (1922) for an *Ustilago* on *Eleusine coracana*, a new name is proposed for this smut, *Ustilago Sydowiana*, of which *U. Eleusines* Syd. is a synonym.

Ustilago Sydowiana Mundkur nom. nov.

Culmicola, flores complete destruens. Sori 1–2·5 cm. longi, nigri, primo membrana ex hospitis textu cooperti, quae postea dissolvitur, et pulverulentam, nigram sporarum molem revelat; columella conspicua. Sporae globosae, sub-globosae vel leviter ellipticae; episporium tenue, margine glabra sed superficie tenuiter punctulata, colore "Mahogany Red" ad "Chestnut" [Ridgway]; diametro 6·7–11·2 μ, medio inter maximum minimumque 9·1 μ.

Habitat *Dactyloctenium scindicum* Boiss. Punjab Plains, Indiae or.

Culmicolous, entirely destroying the inflorescence. Sori 1–2·5 cm. long, black, at first covered by a membrane made up of host tissue which later disintegrates revealing pulverulent, black spore-masses; prominent columella present. Spores globose, sub-globose to slightly elliptical; epispore thin, with smooth edge but finely punctulate surface; Mahogany Red to Chestnut (Ridgway); diameter 6·7–11·2 μ with a mean of 9·1 μ.

On *Dactyloctenium scindicum* Boiss. (=*Eleusine aristata* Ehrenb.) in the Punjab plains; collected by Mr Sultan Ahmad in 1936. Type deposited in the Herbarium Cryptogamae Indiae Orientalis and co-type in the Herbarium, Imperial Mycological Institute, Kew.

XLIX. (1) *U. Sydowiana.* Type.

Diameter (μ)	6·7	7	8	9	10	11	11·2	
Frequency (n)	1	11	18	106	58	4	2	=200

Mean=9·1 μ.

The smut has been compared with *Ustilago Dactyloctaenii* P. Henn., a part of the type specimen having been kindly sent by Dr E. Ulbrich of the Berlin Botanical Museum. *U. Dactyloctaenii* is also culmicolous but its spores are Amber Brown (Ridgway), have a thicker, smooth epispore, and a diameter of 8·5–16·7 μ with a mean of 13·7 μ. The Indian smut is distinct from that species.

L. The covered smut of oats (*Ustilago Kolleri* Wille)

The covered smut of oats occurs wherever oats are grown in India and is the more wide-spread of the two smuts, *Ustilago Avenae* (Pers.) Jens. and *U. Kolleri* Wille, that attack this crop. Sydow & Butler (1906) erroneously placed the Dehra Dun collection of this smut in *U. Avenae* and all later collections were so named until 1934 when the

error was pointed out. Mycologists in continental Europe and North America call it *U. levis* (Kellerm. & Sw.) Magnus, 1894, but according to the Plant Pathology Sub-Committee of the British Mycological Society (1929) the name should be *U. Kolleri* Wille.

Ustilago Kolleri Wille

Ovaricolous; ovaries, basal and inner glumes destroyed. Spores globose to broadly ellipsoidal, Natal Brown to Olive-Brown (Ridgway), light coloured on one side, diameter 4·8–8·7 μ with a mean of 6·4 μ; epispore of medium thickness, but very smooth.

On species of *Avena* (in cultivation) in several parts of India.

Summary

Seventy collections of Indian smuts have been critically examined or re-examined and many of the hosts have been re-identified. Wherever possible the smuts have been compared with type material. The collections are considered to include twenty-five species of which five are proposed as new, namely, *Ustilago Polytocae-barbatae*, *U. Neyraudiae*, *U. Lachrymae-Jobi*, *U. Euphorbiae* and *Tilletia Panici*; two are new combinations: *Tilletia vittata* (Berk.) Mundkur and *Neovossia indica* (Mitra) Mundkur, and there is one new name, *Ustilago Sydowiana*. A smut received from China under the name *Ustilago Coicis* Bref. is reported as a new species of *Tilletia*, *T. Taiana*. An emended description is given of *Ustilago Penniseti* Rabenhorst, with additional notes on *U. Coicis*, Bref., and spore measurements of several non-Indian smuts.

Acknowledgements

I wish to express my thanks to Dr G. R. Bisby and Mr E. W. Mason, both of the Imperial Mycological Institute, Kew, England, for their kindness in going through the manuscript of this contribution and for making many valuable suggestions.

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(*Accepted for publication* 16 *September* 1940)

HETEROGENEOUS FRUCTIFICATIONS IN SPECIES OF *ASPERGILLUS*

By GEORGE HAROLD GOSSOP, EDWARD YUILL and JOHN LEWIS YUILL

(With Plate V)

Introductory

The investigation, forming the subject of the present paper, was the outcome of an observation made by one of us (G. H. G.) on the behaviour of cultures developing from a mixture of spores of two different mutants from a single strain of *Aspergillus niger*.

It is well known that species of *Aspergillus* show considerable instability and occasionally give rise to mutants when kept in culture. A number of such strains arising by mutation and then maintaining their new characteristics indefinitely have been described. Strains of the species *A. niger* have provided several mutants, among which the most interesting examples for our present purpose are the colour mutants described by Elizabeth Schiemann (1912)—*A. cinnamomeus* and her *A. fuscus*, renamed *A. Schiemanni* by Thom. Another strain of *A. niger* (A. 20) has, in our hands, given rise to a number of colour mutants, one of which (A. 20. M. 1) matches in colour *A. cinnamomeus* and another (A. 20. M. 2) matches *A. Schiemanni*. These are the two mutants referred to in the opening paragraph above. From another strain of *A. niger* (A. 66) we isolated a colour mutant (A. 66. M. 2) having much the same colour as *A. Schiemanni*, and later one resembling *A. cinnamomeus* (A. 66. M. 1).

These facts lead one to speculate whether for every strain of *A. niger* there may not be a potential "*A. cinnamomeus*" and "*A. Schiemanni*".

Spores of the cinnamon-coloured mutant (A. 20. M. 1) and of the brown mutant (A. 20. M. 2) had been inoculated together into a liquid medium and incubated. Mould felts developed and eventually became covered with a sprinkling of spore heads—some of which were cinnamon-coloured and some brown, like those of the cultures A. 20. M. 1 and A. 20. M. 2 respectively. But, in addition, there was a third sort of heads, which were practically black.

This unexpected result we proceeded to investigate.

The possibility that the black spore heads were due to chance infection from *A. niger*, improbable as this seemed from their numbers

and regularity, was excluded by repeating the experiment. Also, they did not exactly match in colour those of A. 20, the strain of *A. niger* from which the mutants A. 20. M. 1 and A. 20. M. 2 were derived. They tended to be larger than the heads of either mutant and frequently had shorter stalks.

Therefore, needle transfers were made from single well isolated examples of the black spore heads on to agar medium. Three sorts of colonies developed: cinnamon-coloured colonies, apparently pure A. 20. M. 1, brown colonies, apparently pure A. 20. M. 2 and mixed colonies often with a "sectored" appearance, showing areas of A. 20. M. 1 and A. 20. M. 2 in juxtaposition (see Pl. V, fig. 1).

We were thus confronted by the fact that the single spore heads from which we had made the subcultures could not themselves have been homogeneous. We believe this is the first instance of this kind recorded for *Aspergillus*.

If the black spore heads from which the agar plates were inoculated, had each contained spores of both mutants, such a result might have been expected, though it may be thought that if this were the true state of affairs, it is somewhat surprising that the original heads should be black. A shade intermediate between cinnamon and brown might not unreasonably have been predicted.

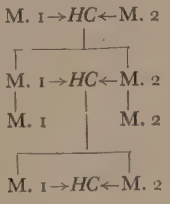
We use the term *heterocaryotic* (for brevity, "*HC*") in referring to these abnormal heads. Their abnormalities must be in some way the result of mixing the two mutants.

Hansen (1938) has reported the occurrence of heterocaryosis in several genera of Fungi Imperfecti. Here the nuclear heterogeneity was found to be in the individual spores which were multinucleate. In the examples we describe, the spores are uninucleate and it is to the spore head as a whole that the term "heterocaryotic" is applied.

Features of mixed or "sectored" colonies

When the "sectored" colonies were more closely examined after some days' incubation, it was found that a number of black *HC* heads had developed and that they were always near the junction of a sector of A. 20. M. 1 with a sector of A. 20. M. 2. Thus, like the original mixed cultures on a fluid medium, "sectored" colonies exhibited three sorts of spore heads: apparently pure A. 20. M. 1 and A. 20. M. 2, within their respective sectors, and black or *HC* heads along the junctions. Further, needle transfers from the apparently pure A. 20. M. 1 heads gave rise to only A. 20. M. 1 colonies, from the apparently pure A. 20. M. 2 heads to only A. 20. M. 2 colonies, but from an *HC* head, to colonies of A. 20. M. 1, A. 20. M. 2 and some mixed colonies, *HC* heads which, in turn, gave A. 20. M. 1,

A. 20. M. 2 and mixed colonies on subculture. Apparently this process could be repeated indefinitely.



Another feature found with some frequency in mixed colonies is the occurrence of what may be referred to as "fused" heads. A "fused" head results when a head of A. 20. M. 1 and a head of A. 20. M. 2 touch and interpenetrate in their early development. Such behaviour is not uncommon with spore heads of a pure strain of *Aspergillus*. When a head of A. 20. M. 1 is found "fused" with one of A. 20. M. 2, the zone of intermingling is marked by the development of more or less blackish colour (see Pl. V, fig. 2), which is of some interest in connexion with the black colour of the *HC* heads. It should be made clear perhaps that with "fused" heads each partner has its own stalk, whereas an *HC* head has only one stalk.

"Parent" and mutant

The results described up to this point followed upon the mingling in some way or another of elements of two species of *Aspergillus* (A. 20. M. 1 and A. 20. M. 2) related to each other by the fact that they are both mutants from one and the same strain of *A. niger* (A. 20).

We next tested what would result from mixed cultures of A. 20. M. 1 with A. 20 and A. 20. M. 2 with A. 20. In both, heterocaryotic heads, not black but some shade of gray or greenish black distinguishable from A. 20, were produced. The *HC* heads on subculture gave rise to mixed or "sectored" colonies.

Extension of the investigation to other moulds

Exploratory experiments with other mutants of *Aspergillus* soon showed that the behaviour described for A. 20, A. 20. M. 1 and A. 20. M. 2 was not confined to this group. Detailed studies of mixed cultures of pairs of a number of available species of *Aspergillus* known to possess mutant relationship were therefore made. In all, heterocaryotic heads, analogous to those first observed, were obtained.

Moulds investigated

The moulds investigated, in addition to the first group, A. 20, A. 20. M. 1 and A. 20. M. 2 already discussed, were:

(2) *A. cinnamomeus* Schiemann. *A. Schiemanni* Thom. (Syn. *A. fuscus* Schiemann).

The above two strains are Elizabeth Schiemann's mutants of *A. niger* and the cultures we used were obtained from the Centraalbureau voor Schimmelcultures, Baarn (Holland) in 1931.

(3) *A. niger*, strain *A.* 66. This strain was isolated by us from an illipe nut in 1937.

A. 66. *M.* 1. This is a cinnamon-coloured mutant which first occurred spontaneously in 1940 as a group of three heads in a culture of *A.* 66.

A. 66. *M.* 2. A mutant from *A.* 66, of about the same depth of colour as *A. Schiemanni*, which appeared spontaneously as a single head in 1939.

(4) *A. nidulans* (Eidam) Winter.

A nidulans mut. *alba*. E. Yuill. This and the previous mould, of which it is a mutant, are described in the *Journal of Botany* for June, 1939.

Culture methods

Except for the first cultures on liquid medium already referred to, agar, or occasionally gelatine, medium in Petri dishes was used. Czapek solution agar was found most generally serviceable, but sometimes an agar medium with the salts of Kardo-Ssyssojewa solution (Kardo-Ssyssojewa, 1936) proved more suitable. Methods of inoculation were employed which insured that spores of any two moulds tested should germinate close to each other. In some experiments, plates were poured with a mixed suspension of spores in melted agar medium; in others, crossing streaks were made on already poured plates with the inoculating loop. Perhaps the simplest method and one of the most effective is to stab the surface of the medium with a needle carrying spores of one of the moulds and to follow this with a similar stab of spores of the other mould in the same spot.

A. cinnamomeus *and* A. Schiemanni

When these two mutants are grown together on Czapek solution agar, *HC* heads in several shades ranging from pale fawn-gray to dead black appear. In the early stages, it is sometimes seen under low magnifications that an *HC* head is made up of chains of conidia of light and dark colours, but uniform colouring is more usual. "Fused" heads showing a dark belt of colour at the junction are also found.

A. niger *strain A.* 66 *and mutants A.* 66. *M.* 1 *and A.* 66. *M.* 2

On Kardo-Ssyssojewa solution agar, A. 66. M. 1 and A. 66. M. 2 grown together give rise to blackish gray *HC* spore heads in a variety of shades. "Fused" heads showing a blackish common zone are also found.

A. 66 and A. 66. M. 1 grown together give dove-gray *HC* heads and "fused" heads not clearly showing a colour change in the common zone.

A. 66 and A. 66. M. 2 grown together on Kardo-Ssyssojewa solution agar produce *HC* heads with freedom. On Czapek solution agar they occur only infrequently. They are found mainly in varying shades of brown and black. Quite early in the process of head production, their composite character can be seen under low magnifications. Such heads present a speckled appearance when young. Even at maturity, it is still fairly easy to see that the chains of spores are not all of one colour. "Fused" heads of the two moulds occur, but do not show any dark zone.

A. nidulans *and* A. nidulans *mut.* alba

Here we are dealing with a green mould and a white mould. The columnar arrangement of the conidial chains, characteristic of the *A. nidulans* group, makes it possible to examine them more easily. Czapek solution agar has been found preferable to other media tested in favouring sporulation and in restricting the growth of sterile aerial hyphae. Mixed cultures develop *HC* heads, which are easily detected under low powers of the microscope and green chains and white chains can both be seen distinctly. Any proportion of white to green chains can occur in *HC* heads. Pl. V, fig. 3, shows a head apparently made up of roughly equal proportions of the two types of spore chains. The columnar arrangement of the chains also allows one to see that the outer chains at least are made up of either green or white conidia throughout their whole length. There is no evidence of the colours being modified by contact of the two sorts.

Conidia, composition of heterocaryotic heads

We have, in the foregoing account, the necessary data on which to form some kind of picture of what we have called the heterocaryotic head. It will be convenient at this point to bring together the relevant facts. The evidence is derived, first, from the results of subculturing *HC* heads, and second, from direct microscopic examination of the *HC* heads or their elements.

Cultural. Entire *HC* heads, transferred and incubated on an agar medium, give rise to mixed colonies, in which spore heads of each of the two moulds which originally produced the *HC* head are found. This demonstrates the heterogeneous character of the *HC* head. Sooner or later, the subculture also shows *HC* heads.

Needle transfers from an *HC* head usually give the same result, but sometimes, only spore heads of one or the other of the original moulds can be found in the subculture; then it may be assumed that the needle happened only to remove spores of one kind.

Single spores, isolated from *HC* heads and grown separately on plates, have never given anything but pure cultures of one *or* the other of the original moulds.

Portions of single spore chains from an *HC* head, removed to plates, developed only pure cultures of one sort or the other.

Microscopic. HC heads from mixed cultures of *A. nidulans* and *A. nidulans* mut. *alba* show groups of two sorts of spore chains: some entirely green, some entirely white.

Mixed cultures of A. 66 and A. 66. M. 2 show *HC* heads, which under low magnifications have a speckled appearance, again suggesting spore chains of two colours.

Mounted specimens of *HC* heads from mixed cultures of A. 66 and A. 66. M. 2, also from *A. cinnamomeus* and *A. Schiemanni*, show two sorts of spore chains, one almost colourless, the other strongly pigmented (see Pl. V, figs. 4, 5).

From microscopic appearances, we have no unquestionable evidence that one chain can contain more than one type of spore.

It must be added that some *HC* heads appear so uniform in their spore colour that two types cannot be distinguished microscopically, but only by cultural methods.

The conclusion to which this evidence points is that an *HC* head bears spore chains of two kinds, each of which normally contains spores capable of reproducing only one variety of mould, and this variety is identical with one or the other of the two moulds whose development in mixed cultures produced the *HC* head.

Discussion

Though direct evidence is lacking to show how conidia of two types can come to be borne on one conidiophore, it is not difficult to picture how this may occur. It is obvious that nuclei from both the varieties of mould to be represented in a compound fructification must first have been present in the hypha which produces the conidiophore. We have observed the occurrence of mycelial fusions as *H*-pieces between two different but related mutants of *Aspergillus* (*A. cinnamomeus* and *A. Schiemanni*), so that the path for nuclear migrations is

clear. It may thus happen that nuclei of two different moulds can come to be present in one foot cell and so enter the developing conidiophore. Here repeated divisions occur, providing a supply of nuclei for the primary sterigmata as these are formed; the distribution of the two types would appear to be a matter of chance. As soon as the secondary sterigmata are produced, each will receive a single nucleus resulting from divisions in the primary sterigmata. Both the primary and secondary sterigmata in the moulds discussed are uninucleate (Thom & Church, 1926; Wakayama, 1931). This is true also of the conidia, which are borne by the secondary sterigmata, in which successive nuclear divisions provide each conidium with a single nucleus. Normally, therefore, one chain of spores can have nuclei of one type only, since the whole chain develops from one sterigma with nuclei resulting from repeated divisions of one nucleus.

It has been made clear that in every experiment so far, in which we have obtained heterocaryotic heads, the two moulds in the mixed culture were related either as mutants of a common "parent" or as "parent" and mutant. The question presents itself whether similar results would be obtained with moulds possessing no mutant relationship. We have made a number of mixed cultures with such moulds, but *HC* heads have never appeared.

It may be asked whether three (or even more) moulds with mutant relationship grown in mixed culture would give rise to heterocaryotic heads containing spores of three (or more) sorts. There seems no inherent impossibility in this, but the chances of the requisite multiple fusions taking place would appear to be less. We have no experimental evidence yet. Such a possibility seems allowed for by Gwynne-Vaughan and Barnes (1930) in discussing fungal anastomoses, where they point out that "fructifications grown under natural conditions may...be compound structures and the product of two or more spores".

Summary

The occurrence, in mixed cultures of species of *Aspergillus*, of fructifications bearing conidia of two sorts is reported.

Such fructifications were formed only when the cultures constituting the mixture were related as different mutants from one strain, or where one mould was a mutant from the other.

The moulds used in this study were various strains of *A. niger*, *A. nidulans*, and a number of related colour mutants.

Evidence, derived from cultural tests and direct microscopic examination, of the dual composition of the fructifications concerned is presented, and an explanation based on mycelial anastomoses is suggested.

ACKNOWLEDGEMENT

We are grateful to Dr G. R. Bisby for reading the manuscript and for valuable criticisms and to Mr A. D. Cotton and Miss E. M. Wakefield for helpful suggestions.

We desire to record our thanks to the Directors of Messrs. John & E. Sturge (Citric), Ltd., for permission to publish this account of work done in their laboratories.

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EXPLANATION OF PLATE V

Fig. 1. Plate colony from a single *HC* head of A. 66. M. 1 and A. 66. M. 2, showing sectors of both these mutants.

Fig. 2. "Fused" heads of *A. Schiemanni* and *A. cinnamomeus*. × 44.

Fig. 3. *HC* head of *A. nidulans* and *A. nidulans* mut. *alba*. Note the alternating groups of light and dark spore chains. × 150.

Fig. 4. Portions of chains of spores of two different kinds from a single *HC* head in a mixed culture of A. 66 and A. 66. M. 2. × 500.

Fig. 5. Part of an *HC* head from mixed culture of A. 66 and A. 66. M. 2, showing spore chains of two sorts. × 500.

Fig. 6. Portion of colony from a single *HC* head of A. 66. M. 1 and A. 66. M. 2, showing M. 1 heads, M. 2 heads and one *HC* head. × 70.

(*Accepted for publication 27 September* 1940)

Fig. 1

Fig. 2

Fig. 3

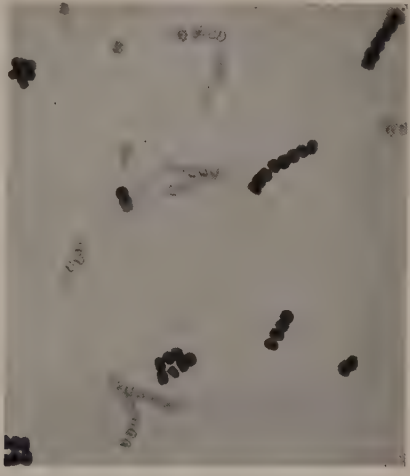

Fig. 4

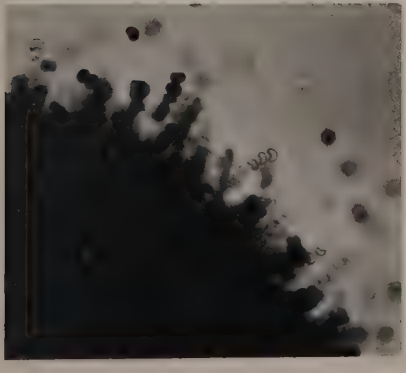

Fig. 5

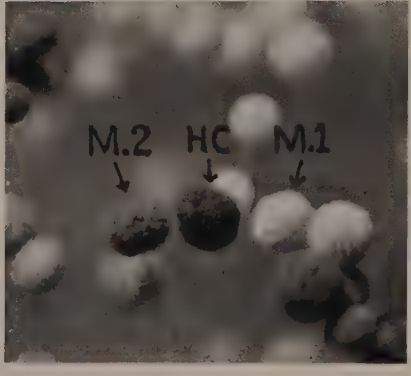

Fig. 6

NEW AND INTERESTING PLANT DISEASES

By W. C. MOORE
Plant Pathological Laboratory, Harpenden

(With Plates VI and VII)

7. Angular leaf spot of apple

In the first note of this series (Moore, 1939*a*) a short illustrated account was given of a new disease of apple foliage occurring in Surrey and believed to be identical with one described three years before by Wenzl (1936) in Austria. The chief symptom of the disease was the presence on the leaves of numerous, small, very angular spots varying in colour from yellow-green to reddish brown, greyish or whitish grey. A species of *Phyllosticta* and an unidentified fungus were associated with the spotting and the former was identified as *P. angulata* Wenzl, the fungus to which the Austrian disease had been attributed. As pointed out at the time, however, no proof had been obtained by inoculation experiments that *P. angulata* was the cause of the disease.

Recently Wormald (1940) reported the same disease from several other localities in south-east England. A species of *Cladosporium* (probably *C. herbarum*) and a *Phyllosticta* were observed on many of the spots. Pure cultures of the latter were compared with *P. angulata*, and although the two fungi were not identical it was concluded that they "may be merely divergent forms within one species". Wormald did not refer to any inoculation experiments with these fungi, but in an appendix to the article he mentioned the occurrence in Kent in May 1940 of an angular leaf spot on apple and pear trees, which had been proved by the entomologists at East Malling Research Station to be caused by a frog-hopper *Cercopsis sanguinea* Geoff. (*Triecphora vulnerata* Illig.). In size, shape and distribution the spots resembled those associated with the *Phyllosticta* and *Cladosporium* but they were dark brown to reddish brown and not yellowish or silver grey, and no fungus was present on them. Dr Wormald has kindly informed me in a letter, that when the affected leaves were examined later in the year (August) the colour of the spots was then typical of Angular Leaf Spot and some of them bore the *Phyllosticta* and *Cladosporium* that he had found previously. I have obtained identical results at Harpenden with leaves on an apple branch that was covered for a day early in June 1940 with a muslin sleeve, into which a few living specimens of *Cercopsis sanguinea* were placed. The leaves, which showed

the reddish brown angular spots an hour or two after the frog-hoppers had been placed on them, were examined at intervals until August, by which time both *Phyllosticta angulata* and a species of *Cladosporium* were present on the spots. I therefore have no doubt that the disease I described as Angular Leaf Spot is caused primarily by the frog-hopper *Cercopsis sanguinea*, and that the fungi associated with the spots develop saprophytically on the tissues killed by the insect.

8. Leaf spot of lettuce (*Septoria Lactucae* Pass.)

Early in July 1940 an unfamiliar disease was observed on some comparatively mature lettuce plants growing in an open, sunny border of my garden in Harpenden. At first it was restricted almost entirely to the outer, older leaves of the Cos variety Little Gem. Close examination was necessary to detect the earliest stage, which consisted of numerous, irregular, pale yellow areas about $\frac{1}{4}$ in. across, scattered over the leaves. These areas were uniformly stippled with minute brown dots that proved on microscopic examination to be pycnidia of a species of *Septoria*. As the areas became larger many of them developed into conspicuous, rounded, elliptical or irregular, brownish olive spots or blotches up to $\frac{1}{2}$ in. long, surrounded more often than not by a light yellow area, stippled brown (Pl. VI, fig. 1). Pycnidia were present in large numbers on the brown spots. The spotting was noticed first at the end of a long spell of dry and sunny weather, and a few days later, after conditions had become dull and humid, the disease began to make headway. Younger leaves became affected and on the older ones the spots spread inwards towards the main vein, causing large portions of the leaves to become brown and withered. The tissues of many isolated spots fell out, leaving irregular holes, $\frac{1}{4}$ in. or more across, bordered by a narrow, often fragmented band of discoloured tissue bearing pycnidia (Pl. VI, fig. 2). At the end of July the heart leaves alone were unaffected and the plants looked very unsightly. Some of the outer leaves had withered completely and others were badly holed or showed brown and yellow patches.

The pycnidia were amphigenous, spherical or somewhat flattened, 54–120μ in diameter, occasionally up to 180μ in the broadest part, pale brown, with a broad shallow beak of darker brown or almost black cells and a well defined ostiole. The spores were filiform, hyaline, slightly or markedly curved, unicellular or 1–3-septate (mostly 2-celled), with rounded ends, often tapering at one end, and variable in size. In the first specimens collected they measured 19–37 × 1·5–3μ (average length of 25 spores 27·5μ) but after a week of dull or wet weather most of them were appreciably longer, measuring 29–40 × 2·5μ (average length 35μ).

Seed of the affected variety had been sown rather thickly in two short rows, and the seedlings were planted out in three or four parts of the garden. All the batches were equally affected, including a few left to mature in the seedling rows. The cabbage variety Ideal was also grown but this was free from the disease at first, and though a number of leaves subsequently became attacked, the spotting did not become extensive in this variety. These circumstances suggested that the disease was introduced with the seed of the Cos lettuce, and fortunately the unused portion of this had been kept. 600 seeds taken at random were examined under a binocular microscope and 4–5 % of them showed several pycnidia plainly visible on the surface as small black or blackish dots (Pl. VII, fig. 3). The affected seeds were mostly smaller than the normal ones and many of them were slightly discoloured. A higher percentage may have been affected, for on closer examination many pycnidia not visible externally were found below the testa, and up to thirty-six were counted on some seeds. Though somewhat darker, the pycnidia on the seed resembled those on the foliage in size and form. Most of them were unripe, but mature spores were found in some, and these were similar to those from the leaves and measured 21–34 × 1·5–2μ (average length of 25 spores 27·5μ). The residual seed of the variety Ideal was also examined, but the *Septoria* was not present on it.

I have been unable to find any previous record or material of *Septoria* on lettuce in this country, but have examined several foreign specimens of *S. Lactucae* Pass. in Herb. Kew., including authentic material in Thümen's *Myc. Univ.* No. 1295, which was included in Cent. XIII published in 1879. The original diagnosis on the label to this is:

"Septoria Lactucae Pass. nov. spec. Maculae ferrugineae, irregulares, angulosae, totam folii laminam mox adurentes; perithecia minima, punctiformia, sparsa; spermatia (spora) filiformia, integra, recta vel curvula, hyalina.

"Parma: Vigheffio in foliis vivis languidisve Lactucae sativae Lin. Jun. 1878. leg. Prof. G. Passerini."

The pycnidia in this specimen are 75–125μ in diameter (mostly about 90μ) and the spores, mounted in water, measure 21–37 × 1·5–2·5μ (average length 28·8μ) and are occasionally distinctly two- or three-celled. The Harpenden fungus is identical with it.

What is now generally accepted as the same fungus was described independently by Peck (1879) from North America in June 1879, with the following rather scanty diagnosis:

"*Septoria Lactucae*—Spots indefinite, pallid or brownish; perithecia minute, scattered, blackish; spores straight or slightly curved, ·0008–·0015 of an inch long. Living leaves of lettuce, *Lactuca sativa*. Illinois. Forbes."

In the literature the authority for *Septoria Lactucae* is sometimes given as "Peck" and sometimes as "Pass.", and if Passerini's name is considered to date from the publication of Thümen's *Myc. Univ.* No. 1295 it is difficult to decide between them. Material of *S. Lactucae* Pass. was also distributed, however, as No. 746 in Fasc. xv of the second series of *Erb. Critt. Ital.*, published in October 1878, and if this was accompanied by a diagnosis Passerini is undoubtedly the correct authority for the name. Unfortunately, war conditions have prevented me from consulting the specimens in *Erb. Critt. Ital.*, but *S. Lactucae* Pass. was included without description among *Fung. Parm.* in *Atti Soc. Critt. Ital.* II (1879), p. 34, where reference is made to both exsiccata, and the one in *Erb. Critt. Ital.* is cited first, which suggests that this was the first valid publication.

Six years after Peck had found his *S. Lactucae*, Ellis and Martin (1885) described *S. consimilis* E. & M. on lettuce from North America as follows:

"*Septoria consimilis*, E. & M.—On cultivated lettuce, Geneva, N.Y., July (Arthur), Newfield, N.J. On brown, dead, rather indefinitely limited spots, $\frac{1}{2}$–1 cm. in diameter. Perithecia, brown, subglobose, innate, amphigenous, 90–100μ, scattered over the spots and visible on both sides of the leaf. Spores filiform, multinucleate, slightly curved, ends mostly obtuse, 30–45 × 2–2$\frac{1}{2}\mu$, hyaline. Differs from *S. Lactucae*, Pass. in growing chiefly on spots, perithecia also a little larger and spores a little longer but not distinguishable by its spores alone."

Shortly afterwards Arthur (1886) pointed out that although *S. Lactucae* Peck was the name in use in North America for the fungus occurring as black or brown specks on the green surface of the leaf, and the form occurring on more or less conspicuous spots was referred to *S. consimilis* E. & M., there was no essential difference between these fungi, and as soon as it was realized the spots were merely incidental to the disease the name *S. consimilis* E. & M. dropped into synonymy. As already stated, however, *S. Lactucae* Peck was antedated in all probability by *S. Lactucae* Pass. and pending confirmation of this* the latter is regarded as the valid name of the lettuce Leaf Spot fungus occurring both in Europe and North America.

Among other specimens of *S. Lactucae* Pass. in Herb. Kew. one is from Sydow, *Mycoth. marchica* No. 2377, collected on *Lactuca sativa* in Germany in 1888, and one in Ellis, *N. Amer. Fungi* No. 345, on leaves of garden lettuce in October 1879. Both these are identical with Thümen's No. 1295. Another specimen, from Roum. *Fungi Gall. exsicc.* No. 2032, occurs in definite spots on *Chondrilla muralis* and seems to be distinct. Very few spores could be found but the

* See Note, p. 350, at the end of this article.

pycnidia are black, more uniform in size and smaller (66–78μ in diameter) than those typical of *Septoria Lactucae* Pass.

There is also in Herb. Kew. a specimen from Thümen's *Myc. Univ.* No. 2095, collected on *Lactuca sativa* at Skaarup in Denmark in September 1881 and named *Ascochyta Lactucae* Rostr. nov. spec. Von Thümen had added to the diagnosis of this the observation "meae sententiae Phyllostictae species", but the fungus is undoubtedly a *Septoria*, indistinguishable from *S. Lactucae* Pass., as already pointed out by Neergaard (1938), who demonstrated moreover that Rostrup had included two fungi under the same name. Rostrup's (1902) description of *Ascochyta Lactucae* Rostr. clearly applies to a fungus collected at Copenhagen in 1894. It is a true *Ascochyta* which was described as *A. suberosa* in notes left by Rostrup, and was published by Neergaard as *A. suberosa* Rostr. nov. sp. in litt.

It is rather surprising that *Septoria Lactucae* Pass. has not been seen in England previously, for it is evidently very widely distributed elsewhere, and in addition to Italy, Germany, Denmark and North America it has been recorded on *Lactuca sativa* from France (Sacc. *Syll.* 3, 551), Japan (Nisikado *et al.* 1938), China (Tai 1937) and the Argentine (Hauman-Merck 1915), on *Lactuca* sp. in India (Butler & Bisby 1931) and on *L. scariola* and *L. virosa* in Germany (Rab. *Krypt. Fl.* 1, 6, 1901, p. 800). It was also listed on *L. scariola* by Thorne (1892) in Ohio and by Ranojević (1914) in Serbia.

Grateful acknowledgement is due to Miss E. M. Wakefield and Miss F. L. Stephens for information about the earlier records of *Septoria* on lettuce.

9. A disease of *Colchicum* corms caused by *Pythium ultimum* Trow

The available information about diseases of *Colchicum* has been summarized by Moore (1939*b*, p. 57), but it is very scanty and several troubles known to exist have never been studied scientifically. One of these came to my notice late in July 1940, when a number of diseased corms were received from the nursery in Buckinghamshire where a root and bulb rot of tulips due to *Pythium* had been observed the previous year (Moore, 1940). Investigation showed that the Colchicum disease was caused by *P. ultimum* Trow, one of two species that had proved to be responsible for the tulip rot. The disease is of annual occurrence in *Colchicum speciosum album* and commonly occurs in *C. byzantinum*. It has also been seen in the newer hybrid varieties President Coolidge and Lilac Wonder, but *C. speciosum* var. *illyricum* appears to be highly resistant to it. It is often late in July before the big fleshy stems of *Colchicum* have become dry enough to part readily

from the corm and so allow the corms to be lifted without risk of damaging them. They are then replanted at the earliest convenient time in August. The disease is generally noticed first after lifting, but rotting starts while the corms are still in the ground. Indeed, some corms are completely disorganized when lifted. Less badly affected ones are wet and sticky below the outer brown skin, which must be removed before the full extent of the damage can be seen. Infection does not appear to take place through the roots, as in tulips, but at the outside of the corms, probably through wounded tissue.

On the side or at the top of the diseased corms examined, there was a crater-like hole 1–1½ in. across, partially filled with soft, wet and rotten tissue. The skin of the corm around the hole was either white and sound, or soft, slightly sunken and pale greyish brown for distances up to 1 in. When the corms were cut through, much or most of the flesh below the completely disorganized mass was found to be soft and discoloured. When first cut the flesh was greyish with a distinct pink or brown tinge, but on exposure to the air the colour usually deepened rapidly and became brown, reddish brown or even blackish. In one corm only slightly attacked the rot had evidently begun at a wound on the side of the corm and had spread in the superficial tissues to produce a pale chocolate-brown band ½ in. wide extending from the top of the corm to the basal plate (Pl. VII, fig. 4). Saprophytic moulds including *Penicillium* developed on the badly decayed parts but a phycomycetous fungus was present everywhere in the affected tissues. This was isolated in pure culture and identified as *Pythium ultimum* Trow. Preliminary inoculation experiments were carried out with it and with another strain of *P. ultimum* obtained from a naturally infected tulip bulb. Both strains induced Watery Wound Rot in Duke of York potato tubers inoculated through wounds and kept three days in moist dishes at 22° C., and both produced rotting in tulip bulbs under similar conditions. A rot resembling that in naturally infected corms was also induced in *Colchicum byzantinum* by both strains, but it developed much more slowly than in tulip bulbs. At the end of a fortnight it had spread, either internally for distances up to 1 in. from the spot inoculated, or superficially in a band ¼ in. wide running from top to bottom of the corm through the place of inoculation. *C. speciosum album* was also successfully infected but none of the eight corms of *C. speciosum* var. *illyricum* inoculated showed the slightest sign of attack.

Note. Confirmation has since been obtained that *Septoria Lactucae* Pass., antedates *S. Lactucae* Peck. A specimen of No. 746 *Erb. Critt. Ital.*, in Herb. Mus. Brit., is accompanied by a diagnosis almost identical with that on the label to Thümen's *Myc. Univ.* No. 1295.

Fig. 2

Fig. 1

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EXPLANATION OF PLATES VI AND VII

Plate VI

Fig. 1. Leaf of Cos lettuce var. Little Gem showing early stage of attack by *Septoria Lactucae* Pass. Note the stippled area around some of the spots.

Fig. 2. Another leaf showing Shot-hole effect and stippling on the right-hand margin of the leaf.

Plate VII

Fig. 3. Lettuce seed bearing pycnidia of *Septoria Lactucae* Pass. × 14.

Fig. 4. Corm of *Colchicum byzantinum* attacked by *Pythium ultimum* Trow. The outer brown scale that normally covers the corm was removed before the photograph was taken.

(*Accepted for publication* 10 *October* 1940)

A METHOD OF ISOLATING SOIL FUNGI

By C. G. C. CHESTERS

(With 1 Text-figure)

While many methods of isolating fungi from soil have been described from time to time, the majority in use at present fall into two categories.

I. Direct isolation from particles of soil scattered over the surface of sterile media. The medium may be taken to the soil to be investigated in sterile tubes or Petri plates, or the soil may be brought to the laboratory in sterile containers.

II. Indirect isolation from a suspension in sterile water containing mycelial fragments and spores which is prepared in known dilutions from the soil examined.

It seemed possible that fungi could be isolated from the soil *in situ* on sterile agar or sterile plant tissues if these could be successfully introduced into the soil without previously being exposed to aerial contamination. Such a method would permit the infection of the agar under actual conditions of soil moisture and temperature, and by using a wide range of media it might prove possible to isolate from the soil fungi not normally obtained from either soil particles or suspensions. The method would require to be simple, fast enough to allow rapid isolation, and capable of giving results at least as accurate as either of the other two methods.

In November 1939 specially designed tubes to hold either agar or solid plant media were constructed, and the results obtained after 9 months' trial suggest that the use of these *immersion tubes* may provide a more precise method of investigating the fungal flora of the soil. Extended reports of investigations using these tubes will be published shortly, but a brief description of the construction of the tubes may be useful to research workers dealing with soil problems.

Immersion tubes can be prepared from either hard-glass test-tubes or from any diameter hard-glass tubing that may meet individual requirements. Each tube has several small holes blown in the lower half of its length. These may be flush with the wall or may extend inwards as capillaries, varying in length and direction as the particular problem requires. The construction of three types will be described, but many modifications are now being experimented with and will be reported on at a later date.

Type I. Direct contact immersion tubes (Fig. 1 A).

This tube has nine holes arranged in a spiral in the lower half of the tube. Each hole is about 0·5 mm. in diameter, and is prepared by drawing a spicule from the wall of the test-tube, cutting it flush with the wall, reheating till the glass has fused round the raw edge, and finally adjusting the diameter of the hole with a warm waxed needle-point to the size required. Each tube must be very carefully annealed after the holes have been graduated.

Capillary type immersion tubes

Type II. Standard pattern (Fig. 1 B).

This type of tube has been most successful for general purposes, and is prepared from a pointed 6 in. × $\frac{3}{4}$ in. hard-glass test-tube. It differs from the former in the fact that it has only six external openings which lead into short tapered, internal capillaries. These are made by heating a localized area of the tube wall, drawing a short capillary side tube, cutting this about 2 mm. from the tube wall, carefully reheating and, when the glass is molten, invaginating the capillary with a warm, waxed needle-point. These tubes require very careful annealing, and the capillaries must be made in rapid succession.

Type III. Special pattern (Fig. 1 E).

This type of tube was prepared for isolating Phycomycetes. It is made from 1 in. internal diameter hard-glass tubing which is cut into 4 in. lengths, each with a tapered point at one end. A bulb with a diameter of about 1$\frac{1}{2}$ in. is blown at this end, and three or four internal capillaries are drawn in the wall of the bulb. Each capillary ends at the same level inside the tube just beyond the top of the bulb. These capillaries are prepared by heating a localized area of the bulb wall until the glass is molten, and then attaching a tapered glass rod on the inside in the centre of the molten area. After removing the bulb from the flame a capillary is slowly drawn upwards on the end of the glass rod. When the capillary is cool the rod is easily snapped off and the capillary graduated to the required length. When all capillaries have been made the bulb is annealed in a soft flame, which gradually fuses the ragged edge at the inner apex of each capillary.

Immersion tubes are sterilized and filled with media while enclosed in a container tube (Fig. 1 D). They are sterilized in an autoclave. Tubes are filled to just above the highest capillary with almost cool nutrient agar. If solid plant materials are used these may be packed into the immersion tube while it is enclosed in its container and the whole apparatus sterilized in an autoclave. Tubes may be filled with

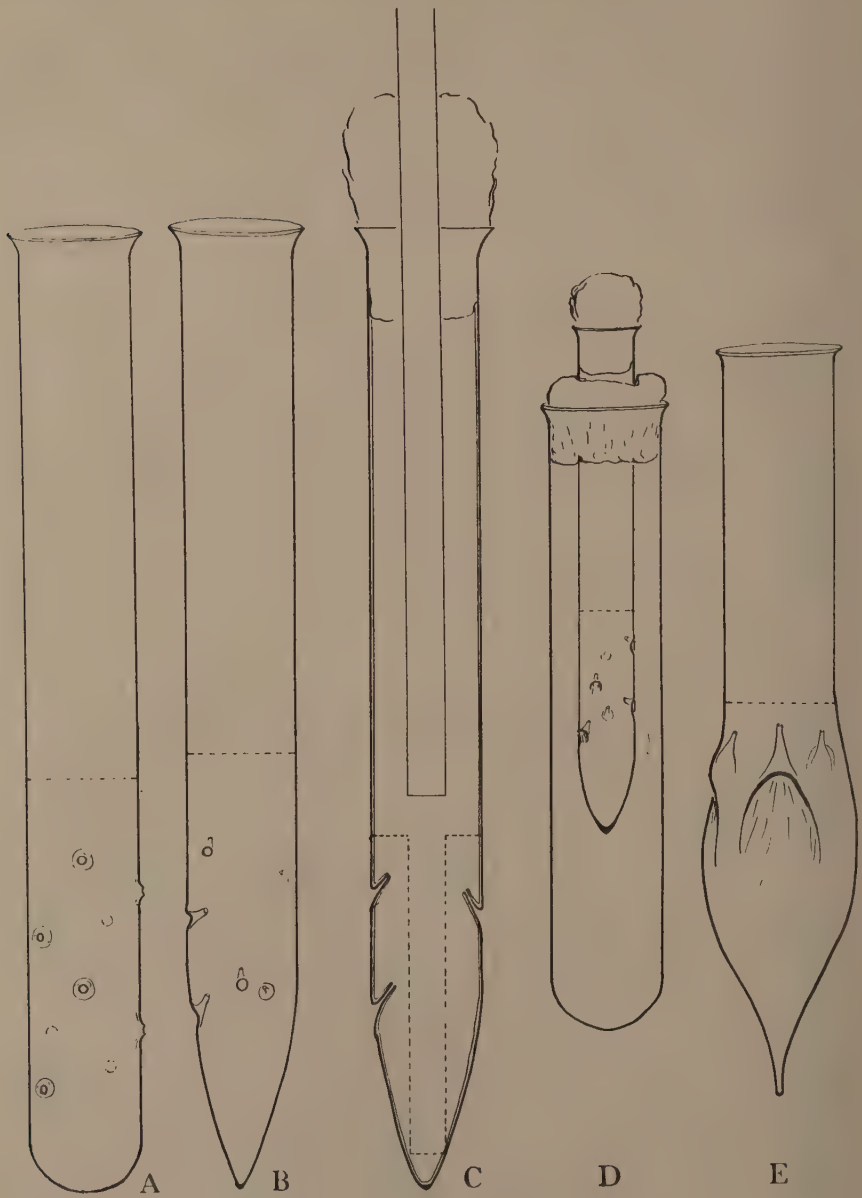

Fig. 1.

a hollow cylinder of agar by immersing a sterile rod into the almost cool agar and withdrawing it after the agar has set (Fig. 1 C).

Immersion tubes are carried to the soil to be examined while still in their containers. The tube is immersed in the soil by quickly withdrawing it from the container and pushing it down into the soil to the required depth. Each tube is covered by a small specimen tube to keep the cotton-wool plug dry. Tubes are normally allowed to incubate in the soil from 7 to 10 days, and are then quickly removed to the laboratory in fresh sterile containers. The colonies which have developed on the medium opposite the capillaries are subcultured to fresh sterile medium in the normal manner.

A wide range of fungi has already been isolated by this method.

(*Accepted for publication* 15 *October* 1940)

A NOTE ON LONGEVITY IN *XYLARIA*

In September 1924, during some experiments with *Dacryomyces deliquescens* (Bull.) Duby, pieces of wood about an inch in diameter and six inches long were thrust to a depth of five inches into damp garden soil. By the end of October, a piece of elm, cut from a fallen branch, bore ten well-developed stromata of *Xylaria Hypoxylon* (Fr.) Grev. It is possible that the dead elm wood already contained the mycelium of the fungus when it was cut and pushed into the soil, but there were no external signs of this.

The piece of elm was left undisturbed until 1938, and it bore, every autumn, a crop of up to a dozen healthy stromata. In December 1938, the wood was transferred to a shady spot in another garden. It then bore the remains of the eight stromata formed in 1938, and had been reduced by the rotting of the more deeply buried end to about one half of its original length, though the top inch which had always been above the level of the soil was still fairly hard. In the new situation five stromata developed during the autumn of 1939, and on 25 September 1940, the beginning of activity for the seventeenth successive autumn was noted, signs of growth being apparent at the bases of two of the old stromata.

In January 1931, one large stroma of *Xylaria polymorpha* (Fr.) Grev. was found on a dead stump of *Prunus Laurocerasus*. The stump was rather more than two inches in diameter, and the wood seemed hard and sound. A piece about eight inches long was sawn off and this was set in the ground, with the base of the stroma just above soil level, close to the *Xylaria Hypoxylon*. In the autumn of 1931, a single large stroma of *X. polymorpha* grew, and in 1932, two small, poorly grown stromata were seen. Subsequently, the fungus showed no activity. The stump was left in position until December 1938, and then contained at least four times as much hard wood as was present in the piece of elm, so that the failure of *X. polymorpha* to appear after 1932 can hardly have been due to lack of nutriment.

B. BARNES.

NOTE: LARGER FUNGI IN THE TROPICS

In connexion with the article which appeared in these *Transactions* (xxiv, 1940, 64–67) entitled "Some problems of collecting larger fungi in the tropics" by G. B. Masefield, I wish to correct some false impressions which may be gathered. Mr Masefield suggests that large fleshy fungi are scarce in numbers and variety in the tropics generally, and states that he has seen no *Boletus*, *Lactarius* or *Russula* in the tropics, and that *Amanita* seems not to occur. These conclusions do not agree with my experience in Malaya, and I would refer to my article on "The seasonal fruiting of Agarics in Malaya" published in the *Gardens' Bulletin*. Straits Settlements, ix, 1935, 79, where the answers to many questions raised by Mr Masefield will be found. I would generalize from my Malayan experience for the whole of tropical Asia and Australasia by saying that larger fungi are abundant numerically, specifically and generically but that their fructifications are seasonal, developing quickly and rotting quickly, during the first rains which follow dry weather, and that if one is not able to visit the forest daily during the right fortnight, no trace of these fungi will be found. As for variety, I have found in Singapore some sixty species of *Boletus*, twenty-six species of *Russula*, twenty species of *Hygrophorus*, fourteen species of *Amanita*, ten species of *Amanitopsis*, thirty species of *Lepiota*, fifteen species of *Psalliota*, twelve species of *Tricholoma*, twenty species of *Clavaria*, and about seventy species of *Marasmius*. One species of *Amanita* has a pileus 20 cm. wide with purple-brown warts 1·5 cm. high: another has a stalk 26 cm. high and a pileus 22 cm. wide and another has a pileus 1 cm. wide and a stem 2 cm. high. Likewise there is a *Boletus* as massive as *B. Satanas* and another as slender as a *Mycena* (*Filoboletus*): some are green, others grey, brown, yellow, red or purple. The species of *Amanita* are related to *A. muscaria*, *A. pantherina* and *A. strobilaeformis*. There is a *Tricholoma* related to *T. decastes* which also grows in large marshes, and another which grows below high-tide level in the mangrove swamps. Perhaps the most spectacular is an Oxford blue *Entoloma* which may reach 12 cm. across the pileus. These examples will prove the idea that tropical conditions are unsuitable for higher Basidiomycetes to be mistaken.

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Erratum

Watson, Mr W. 1923, not 1933.

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